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BIFURCATED ANNELIDS.

BY E. A. ANDREWS.

Abnormal structures among non-vertebrates have come under the observation of everyone who has carefully examined a large number of individuals in any group. Just as there are many cases of duplication of parts occurring among the higher vertebrates, so among the non-vertebrates we have recorded cases of the same nature. As might be expected, this tendency to produce supernumerary parts is most easily noticed in such groups as the crustacea, insects, echinoderms, where the nature of the skeleton aids in the recognition of abnormalities. Even among the soft-bodied animals, however, many cases of abnormal duplication of parts have been recorded.

For the group Annelida, such records are scattered and not generally known or accessible. To bring these together with the hope of eventually obtaining material for a more complete view and discussion is the object of the present article.

We will limit the review to cases in which the main axis of the worm is duplicated, to some extent, at one end of the body, so that the animal has there two left and two right sides, has either two heads or two tails.[1]

In the last quarter of the eighteenth century Charles Bonnet (**1**), while experimenting upon the power of regeneration

[1]The author would be glad to receive references to literature upon this subject and if possible the privilege of examining specimens showing such bifurcations.

in certain freshwater annelids (naiads) found that there was sometimes a sort of tubercle formed upon the body, leading, he imagined, to the formation of new individuals by stolon-like outgrowths! In one case an individual was cut into three pieces; the posterior piece formed a new head for itself and at the same time gave rise to one of these tubercles, which Bonnet regarded as a second head. This specimen is shown in fig. 7, and its bifid anterior end in fig. 8.

Such tubercles occurred at the posterior end also, and in one case, in another species of fresh-water annelid, two definite tails were observed. These two cases seem to have been the only ones noticed among very many individuals carefully observed during these experiments upon regeneration of parts after artificial section.

Towards the middle of the present century Edward Grube (**2**) cites the case observed by Schäffer, who had made unsuccessful attempts to obtain reproduction of lost parts in the fresh water annelid *Sænuris variegatus* Hoffm.

In this one case an individual with two definite tails was found a few weeks after Schäffer had cut the bodies of the annelids into pieces in the hope of having them form new ends.

More recently C. Bulow (**3**) made a long series of experiments upon the regeneration of lost parts in *Lumbriculus variegatus* Gr., and discovered among his specimens some cases in which there were two well-formed tails. In one individual, 5.5 cm. long, each tail was 1.75 cm. long.

About the same time Zeppelin (**9**) found three cases of bifurcated posterior end in the simple, perhaps primitive, annelid Ctenodrilus. Two of these are shown in figs. 1 and 3. These were obtained among several hundred specimens carefully examined in studying the peculiar reproduction by budding found in the Ctenodrilidæ. This process consists largely in the reproduction of lost parts after the animal has spontaneously divided itself into small pieces consisting of only a few somites.

The above cases of bifurcation of the main axis in aquatic oligochætous annelids have been discovered during special

researches upon these small and not commonly observed animals. In their terrestrial allies, however, among the well known earthworms, cases of such striking monstrosities have fallen under the observation of many casual observers.

In Europe Charles Robertson (**4**) described and figured such a case in *Lumbricus terrestris*. As shown in figs. 4 and 5 the body is divided into two equal posterior parts, at the 85th somite. Each begins with a perfect somite and thus leaves a triangular membranous area on the dorsal and ventral sides of the trunk. The length to the fork was two inches; that of each caudal portion $\frac{1}{8}$ inch. Each portion had about 20 somites and contained a portion of the forked intestine, chief blood vessels and nerve trunk; had well developed setæ and a separate anus. The animal appeared to be an adult, having fully and normally developed sexual organs.

This description was drawn from an alcoholic specimen in the Oxford University Museum. F. Jeffrey Bell (**5**), however, had a live specimen of the same species under observation for two months. This was a small immature individual represented in figs. 10, 13 and 14, in which, however, the clitellum began to appear shortly before death. Before dying, the left tail, which was shorter, became less and less active and relatively shorter till finally both tails were thrown off or disappeared and death ensued.

He also observed a dead specimen of *L. fœtidus* in which there was a forked posterior end.

Horst (**6**), in experimenting upon regeneration of lost parts in earthworms, found one 100 mm. long with two tails, each 25 mm. long and quite normally formed. This again was a living specimen when observed.

On this side of the Atlantic, Asa Fitch (**7**) seems to have been the first to record the occurrences of such monstrosities. Among some interesting observations upon the habits of earthworms, regarded as *L. terrestris*, he records finding in his garden in New York State, a live specimen about three inches long with the posterior end divided for nearly one fourth of this length. These appendages are equal, but each only about two-thirds the normal thickness of the body anterior to them.

Each appendage possessed a functional anus. The left appendage appears as a continuation of the body, three somites serving to form a gradual transition from the thicker trunk to the thinner appendage. The right appendage springs out from the gaping suture between the trunk and the first of the three transitional left somites; where this origin of the right branch occurs there is a slight constriction not represented at all upon the left branch. The method of bifurcation seems thus similar to that figured by Robertson, fig. 4.

Very recently C. Dwight Marsh (**8**) records a two-tailed earthworm found in Wisconsin. While alive both tails appear of equal importance, but in alcohol one division is markedly constricted where it joins the body and appears as a mere lateral branch. Each appendage has a branch of the intestine and of the nerve trunk, as well as a functional anus. In alcohol the specimen is only 34 mm. long, the tails each 12 mm.

Among the marine polychætous annelids instances of duplication of the main axis have been recorded for several most widely separated families.

Thus amongst the sedentary Serpulidæ, Edouard Claparéde (**10**) found a *Salmacina incrustans* in which the posterior end was bifurcated as in fig. 2, each part having an anus.

Among the nearly related family Sabellidæ, Brunette (**11**) found, in an unknown species of Branchiomma, one case in which there were two posterior ends, the smaller one making an angle of 30° with the larger. The smaller end is a newly formed one having the fæcal groove less marked than upon the older end, and the ventral shields scarcely visible. The whole annelid is small, 6 cm. x 6 mm., while the new posterior end is 1 cm. long and attached about 15 mm. from the tip of the older posterior end. Here then we have to do with a case of unequal bifurcation, one part appearing as a new formation grown out from the side of the normal animal near its posterior end.

Among the errant Polychætæ, in the family Syllidæ, Paul Langerhans (**12**) found a remarkable case of bifurcation, not of the posterior, but of the anterior end. This, the only well

authenticated case of double-headedness amongst annelids, was seen in a specimen of *Typhlosyllis variegatus* Gr. from Madeira. As shown in fig. 6, the left head has two somites more than the right. As the author notes, and as the figure indicates, the specimen appears to have lost its original head and to have grown there two new ones, having been broken off just anterior to the pharyngeal tube. This, with its dentition, is of the normal size and could not be used in connection with either of the two small heads.

In the same family a case of bifurcation of the posterior end in *Procærea tardigrada* Wb. was observed in North Carolina by E. A. Andrews (**13**). Among several hundred specimens seen during two successive seasons two cases of such bifurcations seem to have occurred, one being found by Prof. Nachtreib. In the one represented in fig. 9 the animal moved actively, each long tail crawling like the normal termination of the body. Each has also the peculiar red transverse bands of this species. Though nearly equal in length and diameter the two tails have unequally perfected posterior tips, as seen in figs. 11 and 12, the right lacking the normal anal cirri. In fact this right tail was interpreted as a sort of lateral outgrowth from the more perfect left tail. This was one of the common non-sexual individuals in which the sexual head was forming upon the fourteenth somite as usual, preparatory to a separation of all the following region as a sexual individual, in this case, a female, which would then have two tails to burden it in its more active mature life.

The only other case that I find record of is that of a *Nereis pelagica*, observed by F. J. Bell (**14**), a specimen sent from Guernsey and exhibited at a meeting of the Zoological Society of London. Beyond the fact that the specimen was bifid at the posterior end no information is given concerning it.

Thus among the many hundred annelids carefully studied and among the thousands more or less casually observed there were found, as far as this imperfect record extends, only about twenty cases of bifid ends. Of these only two were cases of duplication of the head end. Only eight cases have been fig-

ured and these, as seen in the accompanying plate, leave much to be desired regarding the details of the bifurcations.

The period in which these monstrosities arose is not well known; whether they were present in the embryo or were formed in the maturer period of the individual's existence. Yet there is little support for the former supposition, while for the latter we have in two cases good evidence and in many others considerable presumption towards this conclusion. Thus the case shown in fig. 6 can hardly have arisen otherwise than as a consequence of the loss of a normal large head in which the normal pharynx could function. Again, the somewhat doubtful double-headedness of the annelid figured by Bonnet, figs. 7 and and 8, is explicitly stated by him to have arisen after the normal anterior portion had been cut off. Moreover a considerable number of the observed cases have been found while experimenting upon the power to reproduce lost parts.

Granting for the present that these monstrosities have arisen in late life after removal of parts of the main axis or after injuries, we may next enquire how far the two new ends are of equal or unequal value, whether, as figs. 2 and 4 would indicate, the two new parts are equal in origin or whether one, as in fig. 10, etc., is to be regarded as a subordinate part or lateral outgrowth from the main trunk. In both cases of double-headedness, figs. 6, 7, 8 the left is the more complete of the two heads; amongst the cases of bifid posterior ends three have the left more developed, one the right and two others an undetermined side exceeding the other. Only two, figs. 2 and 4, are known to have undoubtedly equal ends.

As far as the evidence goes (and it is too scanty to warrant binding conclusions), there is some indication that one of the heads or tails is a supernumerary part growing out, often on the right, as a somewhat imperfect duplication of the normal end or continuation of the main axis.

Whether the two branches are at first equal, as in fig. 2, and subsequently become unequal or, as seems probable in many cases, one is at first only a side bud on the main axis, cannot be determined as yet.

The interpretation of one of the two parts as a lateral outgrowth allies this process to that described by McIntosh (**15**) in the remarkable *Syllis ramosa*. This annelid lives inside of sponges and presents the anomaly that its buds, instead of being confined to the direction of the main axis, may be also lateral, so that branches and sub-branches arise and produce a complex system with many ultimate tips that may become liberated as sexual animals. How far this lateral budding may be in each case brought about in connection with injuries is not known, but there seems to be an intimate connection between injury and budding, and McIntosh remarks, "the body of the annelid appears to have a great tendency to budding—laterally, terminally and wherever a broken surface occurs."

If, in this remarkable Syllis, budding has been acquired as a result of power to regenerate lost parts, as has been urged by Lang and v. Kennel for other cases of budding among annelids, it is a recent and secondary process. Not so the regenerative power itself which is to be met with in a peculiar form in the double embryos of certain earthworms which arise, as claimed by Kleinberg and corroborated by Wilson, from a single egg. Still further back there seems to be in the ovum a double potentiality. Thus Hans Dreisch[1] claims to have produced complete larvæ from half eggs, that is that the egg, in the Echinus studied, might have formed two larvæ or two adults.

Whether then in the reproduction of lost parts we have the formation at *successive* periods of duplications of the main axis to replace those lost, or in the cases of bifurcation (interpreted as somewhat like lateral budding), we have the *simultaneous* formation of duplications of the main axis, in either case the important fact is that the egg-individual may exhibit a power of reproducing its main axial parts without a sexual process. The bifurcated monstrosities thus exhibit what may be a universally present but latent ability of parts of a highly organized animal to form a complete individual like that to which they belong.

Baltimore, Md., May 5, 1892.

[1]See the AMERICAN NATURALIST, Feb., 1892, p. 178.

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15. McIntosh.—Challenger Reports, xii, 1885.

Explanation of Plate.

Fig. 1. *Ctenodrilus monostylos* x 12½. Zeppelin (**9**), pl. 36, fig. 18.

Fig. 2. *Salmacina incrustans.* Claparéde (**10**), pl. 30, fig. 5F.

Fig. 3. *Ctenodrilus monostylos* x 22½. Zeppelin (**9**), pl. 36, fig. 19; drawn from a living specimen; not that shown in fig. 1, above.

Fig. 4. Posterior end of *Lumbricus terrestris.*. Robertson (**4**).

Fig. 5. Same as fig. 4, but cut open to show intestine and dorsal blood vessel.

Fig. 6. *Typhlosyllis variegatus,* with two new heads. Langerhans (**12**).

Fig. 7. Posterior part of a naiad cut into three pieces and forming two heads (?) Bonnet (**1**), pl. 1².

Fig. 8. Enlarged view of anterior end of fig. 7. Bonnet (**1**), pl. 1^2, fig. 16.

Fig. 9. *Procærea tardigrada,* non-sexual form with a male bud having two tails; drawn from nature.

Fig. 10. *Lumbricus terrestris,* drawn from living specimen. Bell (**5**).

Fig. 11. Posterior end, enlarged, of the left tail of fig. 9.

Fig. 12. Posterior end, enlarged, of the right tail of fig. 9.

Fig. 13. Same as fig. 10 but drawn while in another position.

Fig. 14. Same as figs. 10 and 13.

BRAIN CENTRES.

By S. V. Clevenger, M. D.

Gradual and better understanding of the nature of the brain and its workings is being acquired and disseminated by investigators and thinkers (who are not always one and the same). Twenty years ago the most incorrect ideas concerning the brain existed, consisting of a mingling of superstition with the incorrect phrenological deductions of Gall, Spurzheim, and their followers. Fritsch and Hitzig by experimentation upon dogs, Ferrier upon anthropoid apes, and the imitators and elaborators of their methods, foremost among whom stands Munk, have prepared the way for thinking pathologists and histologists such as Exner, Meynert, Spitzka, and von Gudden, for verification of previous findings.

All too often the patient drudge of a microscopist, fully equipped with special technical knowledge, while able to accurately describe what he saw, was unable to interpret its significance, and quite as often those who are capable of making profound generalizations lack the data, the means or the time, necessary for research. A research with the brain is quite as important as that with the eyes or other sense organs. In fact it was not till the world had investigators with brains as well as eyes, such as Linné, Lamarck, Cuvier, and Darwin, that the investigating eyes knew what to look for, or recognized it when they had found it.

The methods by which the motor centres in the brain were localized are simple enough. After a piece of the skull of an animal was removed, electrical stimulation of certain definite parts of the bared brain invariably produced certain muscular movements. Applied at one point the fingers would move, at another a certain arm movement would occur, and thus leg, tail, face, and tongue movements were induced, and often the muscular coördinations thus evoked were quite complicated, as in swimming, grasping, running, and emotional expression. Cutting away these same small portions of brain tissue pro-

duced paralysis or loss of ability to voluntarily perform these same motions. Tumors or the rupture of blood vessels in these brain regions also cause these paralytic conditions and confirm the results of experimentation.

Destruction of other portions of the brain enabled the localizing of centres for the special senses, and thus we have ascertained that the optic centre is in the hindmost tip of the cerebrum, the auditory is two or three inches farther forward. The centres thus far accurately located are those for sight, and hearing and those controlling the motions of all parts of the extremities, the head, and the vocal apparatus.

Notwithstanding the large size of the olfactory tract at its junction with the brain the smelling centre has not yet been undisputedly made out. There are many portions of the brain the functions of which have not been discovered because present methods of observation are insufficient. There are certain phenomena that follow upon injury of other portions, such as loss of sensation, elevation of bodily temperature, incoördination, vertigo, but, as any one of these kinds of disturbances may be produced by injury to several different areas, strictly speaking we cannot regard such pathological processes as indicating physiological centralization.

The clustering of certain motor nerve beginnings for coördinating processes into closely aggregated nuclei, warrant, to a qualified extent, such terms as crying, laughing, sneezing, and vomiting centres, and as laughing and crying are regarded as emotional exhibitions, the conclusion has been jumped at that the medulla, where these nuclei are found, is the emotional centre. Then there is a sort of hazy idea derived from phrenological assumptions, that there is a centre for memory, another for sexuality, others for combativeness, mathematics, and so on.

Examining by reasoning processes certain faculties that are dependent upon brain integrity, we may arrive at conclusions that are valuable from both positive and negative points of view. The negations afforded by science make us intellectually superior to superstition, though they may not, for the nonce, give us "something else instead" of our fetiches.

SEEING, HEARING AND TOUCH have been considered incidentally in this article, and my contribution to THE AMERICAN NATURALIST, July, 1888, entitled "Cerebrology and Phrenology" contains a discussion of mental faculties in general and in detail from the old and new points of view.

TASTE and SMELL. These two special senses are associated in food discrimination to such an extent as to be often confused one with the other. As might be imagined, the simpler reflex organization of the lower invertebrates relating mouth motions to these senses grow more complex the higher the animal, until considerable brain tissue is concerned. For example, the infant wants to eat everything it sees and its arm and mouth reflexes respond to sight, smell, and taste in endeavors at swallowing everything visible, including its fist and the moon. Olfaction is the main food discriminating sense below the primates, the olfactory bulbs at the base of many lower mammalian brains being very large.

In 1884 I published the original view that the hippocampus major related the olfactory sense to the eating motions. The hippocampus major passes from the olfactory nerve roots backward and finally curls upward and forward to the post frontal region, where are centres for the lips, tongue, and deglutitory parts generally. The Huxley-Owen controversy over the hippocampus minor ended in the former demonstrating its presence in anthropoid ape brains. The animus of the denial was to show a radical difference between "lower animals" and man in the absence of a cerebral part.

I am not aware that anyone has preceded me in announcing the probable functions of the hippocampi. The major is large, and, in keeping with its size, must have subserved some very important life relation, and what is more likely, considering its beginning and termination, its relationship to other brain parts, and its zoological distribution, than that it brought the smelling, tasting, and eating apparatus into coöperation.

In man and the higher apes the olfactory has given way to optic intelligence generally, and in judging of food wholesomeness the eyesight is relied upon mainly, which would

account for the obsolescing features of the major in man, and the absence of the minor below the apes.

The minor projects into the occipital lobe in the region allotted to optic intelligence. The relative sizes of the hippocampi may be explained by remembering that millions of years may have been occupied by Mammalia with olfaction as the main means of food discrimination in their evolution, and that relatively much less time has elapsed since the apes and man first appeared. The hippocampus minor develops as the optic sense becomes the superior means of food judgment; and as the olfactory importance diminishes, the hippocampus major degenerates.

That the taste and olfactory centres are not definitely determined depends, in my opinion, upon the intimate blending of these senses with motor eating centres, paralysis of which becomes so noticeable as to overshadow the sense loss, which latter may be overlooked or regarded as not necessarily an associated derangement. Lesion of the temporal lobes destroying the smelling sense may indicate no more than that olfactory fibres pass through those parts. Taste has reflex connections of a lower than cerebral nature that regulate many involuntary acts concerned in eating, but by association pretty extensive brain distributions are also concerned, more particularly optic, and the glosso-labial motor areas near the sulcus of Rolando. So we may say taste and smell are more generalized than centralized through the brain, and that in man the smelling sense is losing importance.

Consciousness is at its fullest when we possess every faculty intact. Deprivation of the special senses necessarily interferes with consciousness, though, as in the Laura Bridgman case, the possession of a single sense, which has been trained to subserve purposes of contact and communication with the outer world, may suffice. Circulatory disturbances in the brain affect consciousness in various ways, sometimes abolishing it for a time. Proper regard for these and other such matters as sleep, epilepsy, compression of the brain, and a multitude of considerations requiring too much space to even epitomize here, lead me to deny that consciousness has any

localized area in the brain, but resides in the total functionating parts of that organ. For instance, in a healthy brain the entire nervous and vascular tissue, in its solidarity, is the seat of consciousness. Derangement of a part may interfere with action of the brain as a whole, and until adjustment to altered conditions has occurred, there may be deranged or lost consciousness. Now if an attempt at compensation be made by reparative processes, a new consciousness may be instituted, but correspondingly degraded in proportion to whatever permanent damage the brain may have sustained. So while there is no special cerebral seat of consciousness, the entire brain is concerned therein, and the quantity and quality of consciousness will depend upon the equivalent integrity, construction, and size of the brain as a whole.

Memory has been well demonstrated as consisting of memories. There is a memory of what has been learned by eyesight, located in the back part of the brain; forward of this, a memory of all that has been acquired through hearing. Touch memories are scattered over the brain surface co-extensively with motor centres for the peripheries from which the impression proceeds. This is based on Munk's claim that tactile and motor centres coincide, though this is still under discussion. Taste and smell may be safely inferred as having probable centres, and the memory of things tasted and smelt reside therein. In addition to these there are motor memories (the "*Bewegungsbilder*" of Kussmaul), which lie between, and in, the muscles, the nerves that innervate them, and the cells that lie in the outer part of the brain, and which are connected with those nerves. Then memory has no special seat, but has many brain localities devoted to different kinds of memories.

Volition. That the so-called will power controls such a great number of parts would of itself argue that volition exercised the centres of innervation of those parts.

As volition is merely the strongest impulse, and is aroused or checked by single or multiple reflexes, the centres for which are scattered throughout the spinal cord and brain, it is plain that there can be no special seat for the will power. The voluntary activities are the measure of volition and all the

body activities, voluntary and involuntary, instigate it. Molecular changes in and about us influence and control it; digestive processes, fatigue, rest, good or bad air, sicknesses, as well as mental impressions, guide it, raise and depress it. Its starting point is everywhere in the body, its reflex centres are everywhere in the brain.

Sexuality (to borrow a phrenological term) is sometimes apparently augmented by brain injury. This I interpret as indicating that full brain integrity diverts or holds in check the manifestations of an appetite that belongs to every cell of the body. There are automatic spinal cord centres connecting the genitals through the nervi erigenates, but so far as intelligence is concerned in sexuality, a great number of mental associations exist differing between individuals; these are mainly optic in man, and olfactory in most other Mammalia. There need no more be a special localization in the brain for sexuality than for hunger, and these two instincts are at the very foundation of life, and exist in every part of the body, controlling, directly or indirectly, every act and thought. So hunger and sexual desire are co-extensive with the distribution of volition throughout the body and brain.

The Emotions have vaguely been regarded as having several centres or a single centre. Often in physiological writings we encounter the term "emotional centre" and reasons more or less incorrect have been advanced locating this "emotional centre" at the base of the brain.

Emotionalism in a broad sense is nothing more nor less than degrees of excitement. So from this standpoint it is a condition, an exaltation or depression of the nerve centres, and hence it would be absurd to look for its centre. Joy, grief, anger, fear, jealousy, are all conditions which may engage every cell in the body at times. The fact that there may be crying and laughing centres in the medulla do not constitute that portion an emotional centre any more than we are justified in calling the leg centres in the brain cortex, kicking centres. The laugh and cry may be purely automatic and without reference to the emotions at all. Besides, some emotional exhibitions, such as tremblings and pallor, indicate that during emotional excite-

ment nerve force is pretty well diffused throughout the body, and that no particular set of nerves is engaged. It would seem that in such instances there is excellent evidence of the absence of an emotional centre and the shaken up general nervous system can find no special outlet for the feeling.

When a rupture of a blood vessel in the motor centres of the brain causes paralysis, and in brain degenerative states, such as are induced by alcoholism and senility, there is an increase of emotionalism; the patient may cry and laugh easily, but in such instances the higher control is lost, impressions are diverted from former channels in the brain to the more automatic ones lower down, but the emotionalism is the product of brain injury and is a debased condition, and hence has no centre in the brain. The fact that the brain base at its junction with the spinal cord has laughing and crying reflex centres may warrant this area being named an emotional centre in a very limited sense, but strictly speaking, there can be no such thing as a centre for the emotions, for laughing and crying are but two among a great number of emotional exhibitions and they may occur independently of consciousness.

Instinct and Reason. A study of the construction of the nervous system should convince anyone that the more definite the tracts that pass between nerve centres and muscles engaged in habitual performances, the more instinctively are motions enabled. Muscles are developed by exercise, and certain kinds of work give special peculiarities to those muscles, and it is reasonable to suppose that nerve bundles passing to such muscles, and the nerve centres in the cord and brain are, through participating in the work, also developed, arranged, and adjusted, to enable harmonious adaptation of means to ends. When one becomes an adept at piano playing, a trade, etc., many complicated acts may be performed "instinctively," automatically, and even unconsciously, as during somnambulism, some epileptic feats, or in the routine work of daily normal life. We would infer from this that the acts instinctively performed by animals, even when just born, are reflexes that depend upon a definite arrangement of nerve strands transmitted in many cases through ages.

Reason, on the other hand, is often engaged in holding such reflexes in check. Deliberation, hesitation, doubt, antagonize instinct in many ways, and the reasoning processes being the later acquired by all animals are the first to be weakened by age or debility. There can be no such definiteness about the nerve tissues engaged in reasoning processes as in instinctively, automatically performed acts.

An instinct may have its impetus in a brain centre that controls the motions of any particular group of muscles, therefore there can be no special seat for instinct in general but as many different seats as there are brain areas concerned in coördinating the multitude of muscular acts. Reason involves every sense and sometimes controls all voluntary motions, hence its seat cannot be special, and, its operations being general, so must be its functionating mechanism. Furthermore, the more recently formed and less definitely constructed fasiculi and nerve cells are apparently more engaged in reasoning processes than the more fully elaborated and perfected strands for simpler reflex acts, such as are concerned in instinctively performed motions.

70 State St., Chicago.

CATALOGUE OF THE SNAKES OF NEBRASKA WITH NOTES ON THEIR HABITS AND DISTRIBUTION.

By W. Edgar Taylor.[1]

The author has published in the proceedings of the Nebraska State Board of Agriculture a complete catalogue of Nebraska serpents including notes and descriptions of the adults and young.[2] Since the preparation of this catalogue Prof. Cope's review of North American snakes has appeared.[3] This together with the fact that the author has had time to review his own studies and add many other notes is sufficient excuse for offering the present catalogue.

In the classification we have followed Prof. Cope.[4]

The notes given are confined to the Ophidia or serpents of Nebraska. The range of the collection, which was quite a large one, included the whole State, and only specimens actually examined by the author are included. Typical specimens have been preserved.

1. Carphophiops vermis Kenn.

Of the habits of this little snake, or of the young, we can say nothing, as we have secured but one specimen within the State. This one was captured at Peru, Nemaha county, by students of the State Normal School. This species is probably not rare, but is protected by its peculiar habits. Dr. Cooper mentions one specimen as collected in "Western Missouri" which term was probably applied to what is now the state of Nebraska.

2. Ophibolus doliatus coccineus Schleg.

This is one of our prettiest snakes, very docile, not often even making an attempt at defense. It seems to feed largely on

[1]State Normal School, Peru, Nebraska.

[2]Ophidia of Nebraska: Report of the Nebraska State Board of Agriculture, 1891. Hon. R. W. Furnas, Secretary.

[3]A Critical Review of the Characters and Variations of the Snakes of North America, by E. D. Cope. Proc. U. S. National Museum, 1892. Vol. XIV, pp. 589–694.

[4]Ibid.

insect larvæ and worms, though the fact that a young specimen thirteen inches in length contained in its stomach a young of *Storeria dekayi* six inches long is sufficient evidence of its disposition to devour other snakes. Many specimens have considerable resemblance to vars. *triangulus* and *gentilis*.

This species is generally distributed, very variable and somewhat common, though not abundant. We have examined specimens from Cuming, Nemaha and Red Willow counties.

3. Ophibolus calligaster Say.

These snakes are quite abundant and similar in habits to *Pityophis sayi*. They are very quiet, often found around lumber, sidewalks, buildings, etc., where they go in search of their favorite food, such as mice, young gophers, etc. While we have found bird eggs, usually the eggs of the Towhee, Cowbird, Woodthrush, etc., indicating that these eggs were found on the ground, and other food in their stomachs, yet this snake feeds largely on destructive rodents. When frightened it often vibrates its tail similarly to the *Bascanium constrictor* and *P. sayi*.

We have examined specimens from Lancaster and Nemaha counties.

4. Ophibolus getulus sayi Holbrook.

We have seen but two specimens of this snake in Nebraska, one collected in Nemaha county and the other in Lancaster county. Mr. Lawrence Bruner informed the author that he collected a specimen near Kearney. This indicates a general distribution, though this species is probably at no point common.

5. Diadophis punctatus Linn.

These little snakes are popularly known as young "Blue Racers," and, since they resemble the adult Racers more than the young of the latter do, this belief is not strange. This Ring-necked Snake is rather common and found, usually,

under rocks and in and around old logs and stumps. We have examined specimens from Cass and Nemaha counties.

We have not often been able to determine the contents of their stomachs but their food seems to be, principally, small larvæ, insects and their eggs, etc.

All our specimens possess seventeen rows of dorsal scales and Prof. Cragin reports the same for Kansas specimens.[5]

It would seem that Kansas and Nebraska specimens are peculiar in this respect.

6. Liopeltis vernalis DeKay.

We have examined only ten specimens of this species, all of which were collected in Cuming county by Mr. Lawrence Bruner and are now in the collections of the State University and the State Normal. Dr. Yarrow mentions one specimen taken at "Sand Hill" Nebraska.[6] This species is probably not rare but is greatly protected by its color.

We can say nothing as to their food habits further than that they are probably insectivorous and vermivorous.

7. Bascanium constrictor Linn.

The Blue Racer is our most active and agile serpent; is very abundant and is said to destroy Rattlesnakes. It has the same habit of climbing in bushes common to the Black Racer of the Eastern States. This act it performs seemingly for the purpose of basking, and also, probably, for hunting prey. We have never observed this snake in trees of any size, but have often seen it in bushes and underbrush. It seems to climb by extending its form in a skillful manner over a number of small branches in such away that its weight is distributed, thus enabling it to crawl over the smallest bushes such as the hazel.

This serpent is, also, our most daring species and is commonly believed to chase persons. This it probably does

[5]A Preliminary Catalogue of Kansas Reptiles and Batrachians by F. W. Cragin. Trans. Kan. Acad. Sci., 1879–80; Vol. VII., p, 120.

[6]All references to localities as given by Dr. Yarrow refer to his Check List, 1882.

through mere curiosity or owing to the temerity of the individual, as it invariably flees when given an opportunity. If forced to fight it often indicates its displeasure by rapidly vibrating its tail raised as in the case of the Rattlesnake. When in the leaves a perceptible noise may be made in this way. As is well known this snake is an enemy of numerous small birds, robbing their nests of the eggs or young and greatly frightening the mother bird.

A somewhat careful examination of the stomach contents of numerous specimens shows this snake to be a great insect destroyer, the most common insects found being the grasshopper, dragonfly, etc. Other snakes are also devoured in great quantities; the Eutæniæ being most frequently captured. In the case of eating other snakes their desires seem to be limited by ability to swallow only. We have found in some large specimens garter snakes not less than two feet long.

This species is common and well known all over the State. We have examined specimens from Brown, Cuming, Gage, Lancaster, Nemaha and other counties. Dr. Yarrow mentions specimens as collected at the following points: two from "Platte River," one from "Nebraska" and one from "Fort Kearney, Nebraska," and another from "Western Missouri" (Nebraska). Dr. Cooper also mentions collecting specimens in Nebraska but gives neither numbers nor localities.

Bascanium flagelliforme Catesby.

Mr. Garman gives the range of this snake as "Dakota to Texas and the Pacific Coast" and Dr. Yarrow mentions one specimen taken on "Platte River, Mo." (Nebraska). The extremely large collections we have had at our command would have enabled us to find this species if it were common. But as it is reported on excellent authority we include the species in our catalogue without numbering.

8. Coluber vulpinus Bd. and Gird.

We have collected but few specimens of this species, all these being from Nemaha county. Judging from its distribution in

adjoining States it may be found all over the State, but in small numbers. Mr. Garman gives the locality of the species as from "Massachusetts to Nebraska." The small number we have examined has not enabled us to determine the food of the species.

9. Coluber obsoletus obsoletus Say.

This snake is, perhaps, our most noted and skillful climber, often being found on the limbs of the larger trees with head raised as if viewing the surrounding country. It is said to be due to this fact that it is called the pilot snake. It is one of our most docile serpents, and students have, by tying a string around its neck and thus retaining their captive for further observation, watched it climb the trees on the Normal School campus. This it accomplishes not wholly by winding around the tree, but by curving its body in various directions in order to support its graceful form on the rough projections of the bark. The cause of this wonderful success in climbing may be surmised when we are told that birds constitute its choice food. One large specimen contained in its stomach two fledglings of the downy woodpecker, (*D. pubescens*) large enough to fly, which the peculiar nesting habits of the mother bird had enabled the serpent to capture. However, mice and other rodents are frequently captured.

We have examined adult specimens from Nemaha county where the species is by no means rare, and the young from Nemaha and Lancaster counties. Dr. Yarrow mentions one specimen from "Western Missouri" which term at the time of making the collection, 1853 (?), probably was applied to what is now the State of Nebraska.

10. Pityophis sayi sayi Schl.

This snake, the common western bull snake, is one of our commonest serpents and the largest species found within the State possibly excepting the *C. obsoletus.* They are found throughout the State; are comparatively docile unless attacked, when, although non-venomous, their great strength and

weight enables them to make a strong defense. We have often kept them for several days in our laboratory. In several instances when allowed to run at large in the room and after having disappeared for several days they were found snugly coiled away in some cupboard or drawer thought to have been out of their reach. When very much agitated and excited the tail is vibrated rapidly, similarly to the rattlesnake. When in a zinc tank about 2x2 feet these vibrations could be distinctly heard some ten or more feet from the tank. When forced to fight these snakes prefer to get against some object, or coil the body around some bush or stake when they can strike a blow sufficient to defend themselves against the attacks of an ordinary sized dog. However, they never fight as long as there is a show for escape as may be seen by tracing them on an open and almost grassless prairie.

The result of the examinations of the stomachs of these snakes shows that their food is almost wholly made up of rodents, most notably ground mice, but also including rats, gophers, squirrels, moles and similar animals. From an economic standpoint this is our most useful snake, destroying more destructive rodents than any other animal with which we are acquainted.

What meager notes we have on their breeding habits show them to be very prolific, thus accounting for the fact that they are still numerous, notwithstanding their wanton destruction in great numbers.

This species is very abundant all over the State. We have examined specimens from Brown, Dawes, Gage, Lancaster, Nemaha, Sarpy, Sheridan and other countries. Dr. Yarrow mentions one specimen as taken in "Nebraska" and three at "Fort Kearney, Neb."

11. Heterodon platyrhinus Latreille.

These snakes are quite common, seemingly more frequent in eastern Nebraska. They feed almost wholly on insects, insect larvæ and worms, and are always found in a good condition—generally fat—and, furthermore, are certainly worthy of protection, being entirely harmless.

We have examined specimens from Cuming, Gage, Lancaster and Nemaha counties, and Dr. Yarrow reports one specimen from Nebraska. Seemingly displaced in western Nebraska by *H. nasicus nasicus.*

12. HETERODON NASICUS NASICUS Bd. and Gird.

These snakes are common in the middle and western part of the State, especially in the Sand Hills. We have examined specimens from Cuming, Dawes, Sheridan and Red Willow counties, and Dr. Yarrow mentions two specimens from Nebraska, four from the Platte River and one each from South Platte and the Sand Hills.

Food habits similar to *H. platyrhinus.*

13. EUTÆNIA PROXIMA Say.

The food of this snake consists mostly of insects and their larvæ, but also includes small fish, frogs, etc.

The species is common but nowhere abundant. We have examined specimens collected in Nemaha, Saline and Saunders counties.

14. EUTÆNIA RADIX Bd. and Gird.

This pretty snake is found all over the State and in food habits agrees with specimens of *E. sirtalis* of the same size. Earthworms and insect larvæ seem to constitute the bulk of its food.

We have examined specimens from Cuming, Dawes, Lancaster, Nemaha and Sheridan counties. Dr. Yarrow reports one specimen from Nebraska and another from Platte River, Mo. (Neb.).

Form *E. r. twiningii* is found over the whole State but is most typical in northwestern Nebraska.

15. EUTÆNIA ELEGANS VAGRANS Bd. and Gird.

The food habits are similar to other garters of their size. This variety is generally distributed but nowhere common.

We have collected specimens from Gage, Nemaha and Sheridan counties. Dr. Yarrow reports one specimen from North Platte, Neb., one from Platte River, Neb., and two from Nebraska.

16. EUTÆNIA SIRTALIS SIRTALIS Linn.

Food and other habits similar to var. *parietalis.*[6]

We have collected specimens from Brown, Dawes and Nemaha counties. Dr. Yarrow reports one specimen from Nebraska and another from Western Missouri (Nebr).

16 a. EUTÆNIA SIRTALIS DORSALIS Bd. and Gird.

Food and habits similar to var. *parietalis.* Common in the western part of the State. Specimens were collected in Dawes and Sheridan counties.

Dr. Yarrow reports one specimen from Platte River, Mo. (Neb.).

16 b. EUTÆNIA SIRTALIS OBSCURA Cope.

Food and habits similar to var. *parietalis.* Common in the western part of the State; probably the most common variety in southwest Nebraska. We have examined specimens from Brown, Dawes and Sheridan counties. Dr. Yarrow mentions four specimens from Fort Kearney, Neb.; five from Platte River, Neb.; two from Nebraska; two from Missouri River, Neb.; one from Southern Platte, Neb; four from Platte River, Neb.; three from Republican River, Kansas or Nebraska.

16 c. EUTÆNIA SIRTALIS PARIETALIS Say.

This variety is very common in eastern Nebraska but is largely displaced is the western part of the State by vars. *dorsalis* and *obscura.*

[6]Eight specimens which were supposed by us to represent vars. *sirtalis* and *parietalis* were classified by Prof. Cope as "*E. sirtalis sirtalis* an approach to *sirtalis parietalis* in red color tints." The author is inclined to believe that all Nebraska varieties of *E. sirtalis* should be classified as one, notwithstanding great variations. There are a number of forms but all intergrade so as to hardly allow even varietal distinctions.

The full grown specimens of this snake feed largely on frogs, their stomachs often containing two and even three specimens of the full grown leopard frog (*R. virescens*). On one occasion we observed a member of our excursion party immediately after capturing and encaging a large specimen of these garters make a test of its appetite. It voraciously and in succession swallowed three large specimens of the common leopard frog. The snake still seemed anxious for more frogs, but the cries of the latter and the pleading of the young ladies, members of the class, caused the said young man to cease his experiment.

A very peculiar feature of their food habits consists of the fact that specimens of this garter not exceeding two and one-half feet in length almost invariably contain within their stomachs specimens of the common earthworm. Often their stomachs are filled. Other varieties of this species as well as *E. radix* possess the same food proclivities. The manner of capturing these worms would certainly be interesting. We have examined specimens from Cuming, Nemaha and Saunders counties. Dr. Yarrow mentions one specimen from Republican River, Mo. (Nebr.).

17. Natrix leberis Linn.

This beautiful snake is one of our commonest serpents and is very abundant around sloughs and stagnant waters. We have more frequently found this specimen in muddy wet grounds than in the water. This fact, together with the shape of its body and head and the fact that crawfish seem to constitute its principal food has led the writer to think that perhaps this snake is an expert at pulling the crawfish out of the holes made by these forms. We have found as many as five and six crawfish in one stomach and have never found other substances excepting insect larvæ and masses indistinguishable.

We have examined specimens from Gage, Lancaster and Nemaha counties.

18. Natrix fasciata sipedon Linn.

This snake is extremely sluggish, very ill-tempered and unpleasant to handle. Often when brought into our laboratory after being agitated they emitted a very offensive, strong odor which could be detected anywhere within the room. They are very abundant in streams and stagnant waters and are usually found in brush or drifts.

Our specimens are not the typical *sipedon*, but partake partly of the characteristics of both var. *rhombifer* and var. *erythrogaster*. We suspect that the same conditions are true of Kansas specimens since Prof. Snow reports var. *rhombifer* and Prof. Cope var. *erythrogaster*, while the species *sipedon* is also reported by various persons. The reputation of this species for variability is fully sustained in Nebraska—our collection showing specimens of all known shades and distinctness of markings. As in other sections of the country these snakes though harmless are commonly regarded as venomous.

We have examined specimens from Cuming and Nemaha counties. Dr. Yarrow reports one specimen from Nebraska.

The food of this serpent consists almost wholly of water insects and their larvæ, crawfish and fish, being the most fish-loving of all our species. Often the stomach is completely filled with parasitic worms which belong to the class of "round worms" (Nemathelminthes).

19. Storeria dekayi Holbrook.

The contents of the stomachs of these little snakes indicate that they are almost wholly insectivorous. Furthermore the small numbers collected by amateurs, notwithstanding the fact that they are common, shows that their color is a great protection. Also their protective coloration is aided by the dilatation of the body and a disposition to remain very quiet until discovered, these three facts thus showing beyond question great powers of mimicry. Furthermore when the body is dilated the colors are made more grass-like by the exposure of the dingy, dirty edges of the dorsal scales.

We have examined some twelve or more specimens collected in Nemaha and adjoining counties.

20. CROTALOPHORUS CATENATUS CATENATUS Raf.

This massasauga or prairie rattlesnake is common in eastern and middle Nebraska though we have not found it in the extreme western part of the State. We have examined specimens from Gage, Lancaster and Nemaha counties, and Dr. Yarrow mentions one specimen as from Nebraska.

We have often kept this snake encaged in our laboratory but have never succeeded in getting them to eat. They seem to prefer to remain coiled in some dark corner of the cage seemingly awaiting an attack.

The contents of the stomachs of this species show that its food is almost wholly made up of mice and other rodents. Aside from well-known venomous qualities this snake has no bad habits and is decidedly useful. It is said that rats or mice will very soon disappear when the presence of this reptile is known. In at least one instance we have known this statement to be true. It was noticed that rats which a few days previous had been extremely numerous in a cellar had almost wholly disappeared. Within a few days the mystery was solved by finding a huge rattler in the doorway. These facts fully account for the frequent finding of the rattler around old cellars, buildings, etc., where they go to find their choice food.

21. CROTALUS CONFLUENTUS CONFLUENTUS Say.

This species was formerly abundant all over the State, but is now confined almost wholly to the middle and western part of the State, where they are by no means rare. We have examined specimens from Dawes, Hamilton and Sheridan counties. Dr. Yarrow mentions collections made at Pole Creek, Neb., Sydney, Neb., and Fort Kearney, Neb.

Their food habits are similar to *C. catenatus*. This is the species often found in or around the homes of the prairie dogs, where they are most abundantly found during the breeding season of the dogs.

EDITORIALS.

EDITORS, E. D. COPE AND J. S. KINGSLEY.

—THE elements are accumulating at Lincoln, Nebraska, for a rather complicated educational puzzle. The State University was established here some twenty odd years ago. Since that time the State has treated it liberally, and some five or six years ago, under the careful guidance of Dr. Bessey, it ceased being a plaything of sectarian plans and came rapidly forward until it stands to-day one of the strongest institutions of learning in the west. In all future educational matters it will be an important factor. Within recent years Lincoln has developed a regular craze for "University" building. Simply to "boom" real estate, colleges are constantly being founded in the immediate vicinity of the city, it being a poor year which does not see the installation of a new "University" in Lincoln or its suburbs. At last information (now three weeks old) Lincoln had, besides the State University, the following other institutions of so-called higher education: Nebraska Wesleyan University, Cotner University, Union University (we thought the Schenectady institution had the copyright on that name) Normal University, Western Normal College and an Episcopal College, the name of which is not at hand. Six institutions, not one of which can maintain a decent college course, to say nothing of making University pretensions. Land speculation and sectarian pride are responsible for their existence. From the educational standpoint they are entirely uncalled for.

As to their future it would seem as if one or two things could occur. They will either drop absolutely out of existence, or they will develop into fitting schools for the stronger and better endowed State University or for denominational schools in other places. At first sight one would think that there would naturally come about affiliation and union; a development of each in its own line. But apparently not. Denominational pride, and more probably conscious incompetence will prevent any mixing, any exposure of the young to the knowledge that they are receiving the veriest sham under the name of a college education.—K.

General Notes.

GEOLOGY AND PALEONTOLOGY.

Geological Survey of Missouri.—Mr. Arthur Winslow the State Geologist makes the following report of progress during the month of April to Governor Francis as President of the Board of Managers of the Department of Geology and Mines of Missouri: Early in the month field work was actively resumed. The examination of the zinc and lead deposits was taken up in Jasper and Newton counties, and detailed mapping is now in progress there. Examinations of iron ores have been made in Stoddard, Dent, Callaway, Cooper, Saline, St. Clair, Butler and Wayne counties. Field work on the clay deposits has been continued in St. Charles and St. Louis counties. In the office the proofs of the engraved Higginsville sheet and of the accompanying report have been corrected, and good progress has been made in the preparation and revision of the report on the mineral waters, the report on the iron ores and the report on the paleontology of the State.

For May Mr. Winslow makes the following report:

Much attention has been given to the study of the zinc and lead deposits and in this connection examinations have been made in Jasper, Newton, Lawrence, Greene and St. Francois counties. In addition detailed mapping has been prosecuted in Jasper county and about 140 square miles have been covered during the month. Further, there has been collected in Jasper county a large number of charts, showing the location of mining properties, shafts and ore bodies, and a great amount of statistical matter relating to these. The material thus acquired will be used in the preparation of the general report upon the zinc and lead deposits and also in the special report which will accompany the maps of Jasper county now being prepared. In connection with the examination of the iron ores stratigraphic studies of the Ozark region have been prosecuted along the Big Piny and Gasconade Rivers, in Texas, Pulaski, Phelps, Maries, Osage and Gasconade counties. In addition iron ore deposits have been inspected in Ripley, Carter, Wayne and Butler counties. The clays of the State have been subjects of further examination in both the field and the laboratory, deposits having been visited in St. Louis, Jefferson, Wash-

ington, Madison, Bollinger, Carroll, Chariton and Randolph counties. The study of the Quaternary geology of the State has been prosecuted in Jackson, Lafayette, Johnson, Macon, Randolph and Saline counties. In Greene and Polk counties a small amount of systematic geological mapping has been done. The excessive rains during the month have not only made all the field work difficult and disagreeable, but have made certain work impossible and have materially retarded the progress in other directions. It is greatly to the credit of the assistants of the Survey that, notwithstanding the hardships endured and the difficulties overcome, such advance has been made. In the office the preparation of reports has been constantly in progress. This includes the original composition, the revision and preparation for the printer, the correction of proof, the drawing of maps and illustrations. The reports which have thus specially received attention during the past month are the report on the Iron Ores, the report on the Mineral Waters, the report on Palaeontology, the report on the Higginsville sheet, the reports on the Warrensburg, Iron Mountain and Mine La Motte sheets and the report on the Crystalline Rocks.

For June the following report is made:

The excellent weather which has prevailed since the early part of the month has much facilitated the progress of work in the field. Zinc and lead deposits have been examined in Franklin, St. Francois, Madison, Washington, Crawford, Jasper, Lawrence and Newton counties; about 110 square miles have, in addition, been mapped in detail in Jasper county. Clays have been examined in Adair, Randolph, Warren, Montgomery, Audrain, Jackson, Lafayette, Saline, Howard, Callaway, and Pike counties. Iron ores have been inspected in Mississippi, Dunklin, Scott, Ripley, Butler, Carter, Shannon, Howell, Oregon and Ozark counties and the stratigraphy of the country along Current river has been studied in connection with these deposits.

The mapping of the crystalline rocks has been resumed in Wayne, Iron and Reynolds counties. The study of the Quaternary formations has been prosecuted in Saline, Howard, Boone, Callaway, Montgomery, Warren, Ray, Macon and Randolph counties and the terminal line of the drift has been traced almost entirely across the State.

In the office the preparation of the reports on the iron ores, on the zinc and lead ores and on the paleontology has continued and the manuscript of the report on the mineral waters has nearly all been transmitted for revision and preparation for the printer; the Higgins-

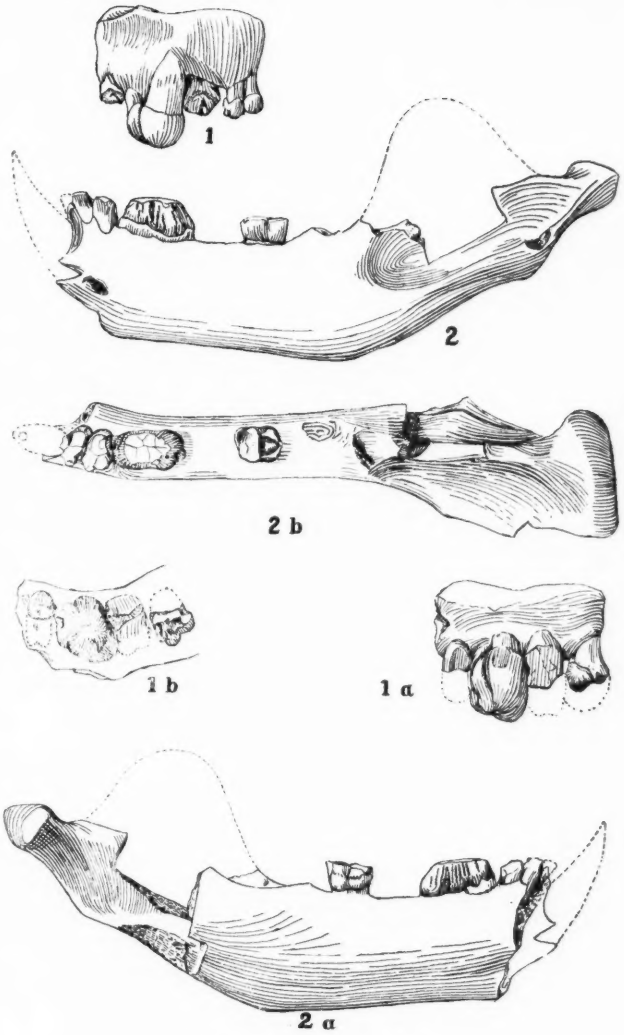
ville map and section sheet and the accompanying report have been printed and will soon be ready for distribution.

During the past month, arrangements have been perfected for intimate cooperation between the World's Fair Commission and the Geological Survey, such that the material accumulated and the great amount of knowledge acquired by the latter organization concerning the geology and the mineral deposits of the State will be applied in the interests of the prospective exhibit in Chicago. The plans adopted and the progress already made in the execution of these plans yield abundant promise that the display in this department will be of the greatest possible credit and advantage to the State.

The Pacific Cable Survey.—The United States steamer Thetis has been making a second survey for the proposed cable between San Francisco and Honolulu, and met with far greater success than was had in the first survey, made by the steamer Albatross six months ago, when the line of survey was from a point on Monterey Bay, direct to Honolulu. The Thetis made a start from Point Conception, 220 miles south of San Francisco and thirty-eight miles west of the town of Santa Barbara, and at the head of Santa Barbara channel. At the point there is high ground and the water shoals off on a mud bottom. As a landing place for a submarine cable everything is favorable. The course taken by the Thetis was nearly due southwest and by way of the great circle. Soundings were made every two miles until 900 fathoms was reached. As the steamer proceeded toward the Hawaiian islands the depth of water gradually increased until 3000 fathoms was averaged for miles. Soundings were taken at intervals of ten miles where the bottom was found of a level nature and where irregular or undulating at distances down to half a mile. The greatest depth reached was 3228 fathoms when about 300 miles from Hilo on the island of Hawaii, which is marked as the landing-place at the islands. Thirty-five miles from Hilo the water shoaled to 1000 fathoms, and from that gradually on to twenty fathoms. There is more water at Hilo than at Point Conception. The island of Hawaii is about 200 miles southeast of Honolulu and can be connected by a short cable. By the Thetis survey the cable will run 2060 miles. The Albatross survey is about fifty miles longer, but not quite as practicable owing to the bottom of the sea being very irregular over a greater part of the first survey.

Fourth Note on the Dinosauria of the Laramie.—Previous notes on this subject have appeared in the NATURALIST for 1888 p. 1108; 1889 p. 715; and 1889 p. 904. In the present communication

PLATE XXII.



Thlæodon padanicus, COPE.

two additional forms are described, and rectifications of synonomy are made.

MANOSPONDYLUS GIGAS.—Gen. et sp. nov. *Char. Gen.*—Dorsal vertebræ with short anteroposterior diameter, and gently concave articular faces. Neurapophyses coössified. At the superior part of the centrum, a deep entering fossa; surfaces of circumference otherwise uninterrupted. Tissue of centrum at borders of articular faces coarsely vesicular. The form of these vertebræ indicates that this genus is allied to the Agathaumidæ rather than the Hadrosauridæ. No genus of either family known to me possesses the fossæ at the base of the neural arch.

Char. specif.—Dorsal centrum a little deeper than wide. Lateral surfaces smooth.

Diameters of centrum.		mm.
Articular face	vertical	205
	transverse	200
Anteroposterior		90

Two dorsal vertebræ are the only remains which I can refer to this species, which is the most gigantic of the Dinosauria of the Laramie known to me. In the same neighborhood, but several hundred yards distant, I discovered a huge supratemporal bone, which differs from those of some of the allied genera in having a simple undulate free border, without tuberosities or processes. Its form is similar to that of Agathaumas, *i. e.* as broad as long posterior to the quadrate suture. There is no evidence that it belongs to this species.

CLAORHYNCHUS TRIHEDRUS.—Gen. et. sp. nov. *Char. Gen.*—This genus is established on a rostral and predentary bones of a species of the Agathaumidæ, which were found together and with the fragments of a massive supratemporal bone. They are distinguished by their absolutely flat inferior faces, there being no alveolar ridges as in the forms described by Marsh. They are not compressed but are as wide as long. They are not adapted to the muzzle of Monoclonius, where the rostral bone is compressed. (*M. sphenocerus.*)

Char. specif.—Rostral and predentary bones as wide as long, with flat inferior face and rounded superior median angle. Transverse diameter rather exceeding the vertical. Sides convex. All the surfaces furrowed by coarse grooves which terminate in foramina.

The short wide form of this species differs from that seen in the species of the family Agathaumidæ which have been yet described.

The extremity of the beak had apparently a horny sheath and was adapted for crushing comparatively hard substances.

AGATHAUMAS COPE—Professor Marsh (Amer. Journ. Sci. Arts, 1892, p. 83) endeavors to show that this genus differs from any of those described by him by quoting characters from my description of the type specimen. Since my last description of that genus was published (1875), I have studied part of a skeleton obtained by Dr. J. L. Wortman in Dakota, of which the parts are undistinguishable from those of the *Agathaumas silvestre*. These include an ilium in much better preservation than that of the type, and I am enabled to correct some of the statements contained in my original description. I stated that there is no facet for the pubis at the front of the acetabulum. The surface at this point is broken in both of my specimens, but it is altogether probable that the structure at this point does not differ from that of the allied forms. The ischiadic suture is in like manner obscured by injuries in the type specimen. The Dakota specimen is perfectly preserved at this point, and displays a large convex sutural surface for the ischium, thus showing that my original description was imperfect in this point. The number of sacral vertebræ in the original specimen is not exactly determinable—only approximately, but this region is identical in character with that of other members of the family. That the *Agathaumas silvestre* is one of the largest species of the family is indicated by the following measurements of the Dakota specimen:

		mm.
Length of ilium		1465
Length of tibia		940
Diameters of tibia	greatest proximal	325
	greatest distal	290
Diameters of dorsal centrum	anteroposterior	95
	vertical	138
	transverse	137

The centrum of the dorsal vertebra is slightly opisthocœlous.

PTEROPELYX COPE—This genus was described by me in THE AMERICAN NATURALIST for October, 1889 p. 904 (published March 5th, 1890), It has been subsequently named by Marsh, Claosaurus, in the American Journ. Sci. Arts. for May, 1890 (p. 423).—E. D. COPE.

On a New Genus of Mammalia from the Laramie Formation.—In 1881 I had the pleasure of announcing the existence of Mammalia in the Laramie formation, and described the new genus

and species of Multituberculata, *Meniscoëssus conquistus*. Since then Prof. Marsh has described several species from the same formation, exaggerating the number very considerably, as has been precisely shown by Prof. Osborn. I now introduce to notice another species, which represents a new and peculiar family of Marsupialia or Monotremata, and which throws considerable new light on some of the species described by Prof. Marsh. The material in my possession consists of a mandibular ramus of the left side which is nearly complete, and which contains three premolars with alveoli of the anterior premolar and canine, and a fragment of the last true molar; with another true molar. About one hundred feet from this specimen was found a part of the right maxillary bone containing an entire last premolar with parts of the penultimate premolar, and first true molar; a molar lacking the protocone was found close to this fragment, and evidently belongs to it. So close is the resemblance in character between the teeth of the two jaws, that I am satisfied that they belong to the same species, and probably to the same individual.

THLÆODON PADANICUS.—Gen. et. sp. nov. *Char. Gen.*—Dental formula, I. $\frac{?}{?}$; C $\frac{?}{1}$; P. m. $\frac{?}{4}$; M. $\frac{?}{?3}$. Inferior canine robust, one rooted. Premolars $^{1\,2\,3\,4}$ two-rooted; $^{1\text{-}2}$ three-rooted. Posterior premolar each jaw with robust, convex, swollen crowns, without heels or accessory cusps. Superior true molar tritubercular, with large internal cusps, and small external cusps; intermediate cusps present. Inferior premolars 2–4 with transverse crowns. Inferior true molar with anterior trigon and posterior basin; the former transverse, the latter with posterior angular cusps.

The genus Thlæodon represents apparently a new type of Marsupialia, or possibly of Monotremata. In the entire absence of the mandibular angle it resembles Ornithorhynchus, and also the genus Triconodon Owen, and several other genera of the Jurassic system. It differs from most of the genera of the Jurassic non-Multituberculata, in the normal number of its teeth, which apparently agrees with that typical of the class; viz. I. 3; C. 1; Pm. 4; M. 3. The number of true molars may be four, but the space which is preserved in the lower jaw is as appropriate to three; either number requiring that the teeth should present somewhat unequal dimensions. The form in any case indicates an ancient and inferior type, specialized in the direction of dental reduction, and in the development of a molar or crushing type of premolars. The true molars are also specialized in the direction of modern forms, the superior being tritubercular, and the inferior

quinquetubercular, with trigon and heel. The genus may be referred to a new family, the Thlæodontidæ, with the following definition. Mandible without angle, but with inflected inferior border, and a coronoid process. Molars $\frac{3}{3}$-tubercular; premolars simple. Canines well developed; incisors reduced.

The discovery of this genus enables me to suggest a further reduction on the number of genera named (but not described) by Prof. Marsh. It is now indicated that the forms with only the simple and robust premolars which have been described by Marsh under the name of Stagodon, belong to the animals of which molars only are described under the names of Didelphops, Didelphodon, etc., and should be referred to identical genera and species. What the simple-rooted tooth which served as the type of Marsh's Stagodon really is, remains to be ascertained, but some of the premolars of Mammalia described by him under that name resemble those of Thlæodon, although much inferior in size and less robust than are those of *T. padanicus*. The largest species described by Marsh, under the name of *Stagodon validus*[1] is not very different in size from the *T. padanicus*, but the number of premolars is probably smaller, or if equal, the anterior ones are longitudinal and not transverse. The description of Marsh is valuable as indicating the character of the incisors, a point not elucidated by my specimen. Marsh refers these forms to a family Stagodontidæ[2] which he does not define; moreover the generic character of the real Stagodon remains undescribed.

The widely transverse condyle of Thlæodon shows that the movement of the lower jaw in mastication was vertical or orthal, as in the opossums, and not propalinal as in the Multituberculata, or loose as in the modern Monotremata. The true position of the family must, however, remain doubtful until other portions of the skeleton are discovered. The genus Thlæodon may be simply a form of Didelphyidæ with simple robust premolars.

Char. specif.—The surface of attrition of the superior premolars is oblique to the vertical axis of the crowns, the latter spreading outward and downward in relation to the maxillary bone. The crown of the first premolar is very much larger than that of the second, and is subquadrilobate. This form results from the presence of three grooves which rise from the interradical spaces, but which do not attain the summit of the crown. The latter is obtusely rounded, with the anteroexternal diameter in excess of the anterointernal diameter.

[1]Amer. Journ. Sci. Arts, 1889, August, p. 178. Pl. vii, figs 22–5.

[2]Op. cit. 1892, March 256. Pl. viii, fig. 7.

The enamel is coarsely wrinkled when not worn by use. The roots are encased in a layer of cementum, which forms a narrow ledge round the base of the crown. The true molar preserved has a transverse triangular crown. The paracone is conical and the metacone is compressed so that its worn section is anteroposterior. A longitudinal ridge notched in the middle occupies the space between the paracone and metacone. The protocone is represented by a large worn surface, whose interior extremity is unfortunately broken away. The paraconule forms a narrow transverse crest which passes in front of the paracone. The metaconule on the other hand is within and anterior to the metacone.

The alveolus is all that indicates the character of the inferior canine. It is deep, extending to the base of the ramus, and is directed with a straight axis, a little forward of upward. The side is longitudinally keeled near the fundus on the external side. The anterior three inferior premolars are very narrow, extending transversely across the alveolar line, with divergent roots. The crowns are so worn that their structure is not determinable. The first inferior premolar, is very robust, its crown equaling those of the other three in anteroposterior diameter. The horizontal section of the crown is a longitudinal ovoid. The anterior border is broadly rounded; the posterior bilobate, the internal lobe more prominent than the external. There are two roots, of which the posterior is grooved on the internal side, giving the appearance of three roots, a form to which the alveolus is adapted. Two grooves rise from these grooves on the inner side of the crown, and there are two or three obscure grooves on the external side. Enamel rough. Roots with cementum layer, which forms a narrow ledge round the base of the crown. Like the superior true molar preserved, the inferior truemolar is remarkable for its small size as compared with the premolars. It is of robust form, presenting anteriorly a transverse trigon, which is worn to a uniform surface in the specimen, but displays traces of the paracone and metacone. A strong cingulum marks the external part of the anterior base of the protocone. The heel is short and wide, and has a raised border surrounding a basin. The border consists of external and internal compressed cusps, and a small median one soon confluent with the internal one. No cingula other than the one described. The last inferior molar has left only the base of its heel, which was evidently more elongate than that of the other molars. The coronoid process has a base much extended anteroposteriorly; it is broken off. The masseteric fossa has a strong anterior rib border, but the inferior border is very promi-

nent, being a horizontal ledge extension of the inferior face of the ramus, which rises gradually to the internal extremity of the condyle. The condyle is unusually extended transversely for the size of the ramus; the extension being principally external. The internal inflection commences below the posterior base of the coronoid process and its border extends diagonally inwards and anteriorly. It bounds a large dental foramen and canal.

Measurements.	mm.
Length of ramus from canine alveolus to and including condyle	75
Length from last true molar to and including condyle	37
Length of inferior premolar series	17
Diameters of last premolar { transverse	6
Diameters of last premolar { anteroposterior	8
Diameters of true molar { transverse	4.5
Diameters of true molar { anteroposterior	5
Depth of ramus at premolar 1	15
Depth of ramus at molar 3	16
Transverse diameter of condyle	16
Diameters superior premolar 1 { transverse	8
Diameters superior premolar 1 { anteroposterior	7
Anteroposterior diameter true molar ? 2	5

The jaws are about the size of those of the gray fox, *Vulpes cinereo-argentatus.*

Prof. Marsh (Amer. Jour. Sci. Arts, March, 1892, p. 251) regards the fauna of the Laramie as widely different from that of the Puerco, which succeeded it. He says "the more the two are compared the stronger becomes the contrast between them." It is true that no Ungulata have been yet found in the Laramie, while they abound in the Puerco, but we cannot be sure that they will not yet be found; the probabilities are that they existed during the Laramie, and that it is due to accident that they have not been obtained. But the Multituberculata of the two faunæ are much alike. Thus the *Dipriodon lunatus* (Marsh l. c., Pl. v, fig. 7,) appears to be a species of Ptilodus Cope, and the *Cimolodon nitidus* (l. c. vi, fig. 9,) is either a species of that genus or of Neoplagiaulax Lem., both genera characteristic of the Puerco.

Explanation of Plate.

All the figures natural size.

Fig. 1. Fragment of maxillary bone external view: 1 *a* internal view; 1 *b* inferior view.

Fig. 2. Left mandibular ramus external view: 2 *a* internal view; 2 *b* superior view.—E. D. Cope.

What is Lophiodon?—Under this generic head the French, German and Swiss palæontologists have gathered a number of very diverse types of molar teeth. In the recent memoir[1] of Prof. Rütimeyer upon the Fauna of Egerkingen and his earlier memoir[2] we find a series of beautiful figures in which the distinctive characters are very clearly brought out. They leave little doubt in my mind that the genus *Lophiodon* which has long been a sort of corral for all the fossil lophodont perissodactyls of Europe, in which the premolars are not like the molars, should be split up not only into a number of genera, but that these genera should be placed in a number of distinct families. This union of these forms under one genus, has been a natural result of the isolated condition in which the types have been found and the re-determination of these forms is only rendered possible by the complete series of upper and lower teeth which are now found in the Eocene.

I am not at present in a position to attempt to review these forms thoroughly for I have not at hand the types, nor all the early literature, nor the recent memoir of M. Filhol.[3] I merely offer a few preliminary notes, availing myself of the admirable figures and descriptions of Rütimeyer.

Turn first to Prof. Rütimeyer's later volumes:

The references are to his plates. *Lophiodon annectens* Rütimeyer, (Taf. I, fig. 12–13). These molars have the same characteristics as those of the primitive Tapirs, and bear a most striking resemblance to those of *Isectolophus annectens*[4] from the American Eocene; this resemblance extends not only to the relations of the cusps and crests but to the development of a complete cingulum around the crown.

Lophiodon cartieri Rütimeyer, (Taf. I, fig 12). The characteristics of this type (Fig. 10 *b*) are that the protoloph springs from the paracone, the metaloph rises from a point slightly in front of the metacone, the paracone is conic while the metacone is slightly flattened upon the outer surface, the parastyle is low, the cingulum is feebly developed below the paracone. These are the characteristics of the series to which *Heptodon* Cope and *Helaletes*[5] Marsh belong. The premolars

[1] "Die Eocäne Säugethier Welt von Egerkingen," Zurich, 1891.

[2] "Eocæne Säugethiere aus dem Gebiet des Schweizerischen Jura," 1862.

[3] Filhol. "Vertébrates fossiles d'Issel," Mém. Soc. Géol. de France. 1888.

[4] See Osborn, "Mammalia of the Uinta Formation," Plate X, fig. 1.

[5] *Desmatotherium* Scott is a synonym of Helaletes. See Bull. No. 3, E. M. Museum, 1883, Plate viii, fig. 3.

referred by Prof. Rütimeyer to *L. annectens* are very similar to those of *H.* (*Desmatotherium*) *guyotii* Scott, from the Bridger Eocene.

Lophiodon isselensis Fischer, (Taf. I, fig. 9). This is a distinct type. The figure agrees closely with that given by Gaudry[6] of a complete series of upper molars. This exact type of molar has not been found in America. So far as known the true *Lophiodon*, like *Palæotherium*, was confined to Europe. The characteristics of this *Lophiodon* molar are that both paracone and metacone are conic and nearly of the same size, in this respect it resembles the Tapir, but it differs widely from the tapir in the origin of the transverse crests, for the protoloph passes up to the paracone and the metaloph springs from the metacone, whereas in the Tapir these crests spring from the anterior base of the external cusps.

Turn now to Prof. Rütimeyer's earlier volume:

Lophiodon rhinocerodes Rütimeyer, (Taf. I, fig. 4). The type molar of this species is, as the name implies, of the true rhinocerotine pattern. It is closely similar to the first upper molar of *Amynodon* (*Orthocynodon*) *antiquus* from the upper division of the Bridger Eocene, as figured by Scott and Osborn,[7] except that the tooth is much larger and the parastyle is more prominent. The lower canine is quite different. This form therefore is distinct from *Amynodon* in several features.

Lophiodon tapiroides Cuvier, (Tab. II, figs. 15–26). The first and second molars have nearly the true tapir pattern. The protoloph joins the robust parastyle. The metaloph rises half way between the paracone and metacone. The third molar, however, is not tapirine for the ectoloph is abbreviated as in the rhinocerotine type, in *L. isselensis*, and in *Heptodon*.

Lophiodon parisiensis Gervais, (Tab. III, fig. 27–35). This molar has no exact counterpart in the American Eocene.

Lophiodon cartieri Rütimeyer, (Taf. III, fig. 38–40). These molars are precisely similar to those of the middle sized *Hyrachyus*, *H. agrarius* of the Bridger Eocene.

Egerkingen, Species.	Bridger, Nearest Allied Form.	Family.
L. annectens	Isectolophus annectens	Tapiridæ
L. cartieri	Hyrachyus eximius	Hyracodontidæ
L. rhinocerodes	Amynodon antiquus	Amynodontidæ or Rhinocerotidæ
L. isselensis	unique	Lophiodontidæ.
L. parisiensis	" ?	"
L. tapiroides	"	"

[6] "Enchainements du Monde Animal," fig. 72.

[7] E. M. Museum Bulletin, No. 3, Pl. V, fig. 2, 1883.

The conclusions here arrived at are: First, that the Egerkingen fauna, which Prof. Rütimeyer has already shown to contain a surprising number of New World forms, embraces also the true *Hyrachyus* and *Isectolophus* types, also a form ancestral to the Rhinocerotidæ. Second that the character of the external cusps and the point of union of the transverse crests with them are so diverse that some of the different species referred to *Lophiodon* probably belong to distinct genera. I find that the forms and relations of these cusps and crests are absolutely constant and distinctive in the families of American lophodonts and it is highly improbable that the single genus *Lophiodon* should embrace *specific* molar types as different from each other as the *family* molar types are in the American Eocone.

The question, what is Lophiodon? is yet to be answered. Where does it stand with reference to the tapirs, rhinoceroses, hyracodonts?—HENRY F. OSBORN, American Museum of Natural History, New York, July 12th, 1892.

MINERALOGY AND PETROGRAPHY.[1]

Mt. Hekla Liparites.—The material of three new liparite streams from the vicinity of Mount Hekla, in Iceland, and that of the one described by Preyer and Zirkel[2], have been examined by Backström.[3] In all the rock consists of phenocrysts of orthoclase and green pyroxene in a more or less glassy hyalopilitic groundmass without peculiar features. One specimen contained small grains of olivine and another accumulations of tridymite. None of the streams originated at Hekla. Their source is not known. A granophyre from the north coast of the Snäffel Peninsula is mentioned by the same author as containing plagioclase grains, surrounded by orthoclase zones, and these in turn by micropegmatitic intergrowths in which the orthoclase is orientated with the same mineral in the zone around the plagioclase. This and other granophyric liparites in the neighborhood are very similar to the 'Krablite' inclusions thrown out from the crater of Viti. Of the other liparites of different ages described by the author some are trachytic in character and others are granophyric. In discussing their general features Backström separates them into true liparites, liparite glasses and granophyres, composed essentially of feldspars, pyroxene, iron oxides, zircon and glass, to which are sometimes added quartz, tridymite, apatite, olivine and occasionally hornblende, biotite, hypersthene and sphene. The rarity of biotite is notable. Of the feldspars plagioclase was found in every specimen examined and sanidine in but few. Nevertheless the percentage of CaO in the rocks is small. Upon comparison of seventeen analyses of fresh specimens of the Icelandic liparites it is found that the amount of sodium in them exceeds that of potassium, and that in this respect the Iceland district differs materially from that of the Great Basin and of Hungary.

Bostonite and Monchiquite from Lake Champlain.—A recent abstract of a paper on the trap dykes of the Lake Champlain Valley by Messrs. Kemp and Marsters[4] is very interesting, as it makes known the existence there of two rare types of dyke rocks, bostonite

[1]Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.

[2]Reise nach Island. Leipzig, 1862, p. 346.

[3]Geol. Fören. Forh., xiii, 7, p. 639.

[4]Trans. N. Y. Acad. Sci., xi, 1891.

and monchiquite. The bostonite[5] is usually of a creamy or brownish white color. Its structure is typically trachytic, with a few phenocrysts of orthoclase in a groundmass composed of rods of this mineral and of anorthoclase, and between these little masses of quartz. No dark silicates occur in any of the sections examined. An analysis of the rock gave:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Loss	Total.
62.28	19.17	3.39	1.44	tr.	5.93	5.37	2.33	=99.91

The specific gravity is 2.648. In several places dykes were noted in which the bostonite cements angular pieces of other rocks forming an eruptive breccia. The included fragments are sometimes slate and red quartz that show no effects of contact action, and sometimes rounded masses of norite, quartzite and limestone, whose shapes are due largely to absorption by the eruptive. The monchiquites consist chiefly of zonal augite, brown hornblende and biotite crystals, and olivine in a feebly refractive groundmass that may be an altered glass. The augite and hornblende are in two generations and the other minerals in but one. An analysis of one specimen gave:

SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	K_2O	Na_2O	Loss	Total
40.37	17.86	14.45	.38	17.61	1.63	.83	1.29	4.47	=98.89[6]

Besides the two types mentioned there occur also in the region many dykes of diabase and camptonite.

The Serpentine of the East Central Alps.—The serpentine occurrences within a restricted area in the East Central Alps have been examined by Weinshenck[7] with a view to learning something of the origin of the rock. Its irregular masses imbedded in crystalline schists consist of serpentine, talc, etc., that were formed by the alteration of a pyroxenic aggregate. At the contact of the rock with the neighboring schists has been produced a great variety of hornstones, among which may be mentioned garnetiferous and epidotic kinds containing much diopside, vesuvianite, etc. The existence of contact effects around the serpentine and the presence of dykes of the latter rock in the surrounding schists indicate to the author that the mother-rock of the serpentine was an eruptive pyroxenite.

[5]AMERICAN NATURALIST, 1891, p. 573.

[6]Given as 99.39 in original.

[7]Habilitations-chrift. München, 1891.

Petrographical News.—Several banded inclusions from the tonalite of Mte. Aviole in the Tyrolese Alps have yielded Salomon[8] some interesting observations. In one of the specimens one band is composed chiefly of hornblende so filled with elliptical inclusions of quartz, augite and glass that but a mere skeleton of the hornblendic material binds them together. A second band consists largely of augite. The third is principally an intergrowth of quartz and plagioclase in the form of a mosaic, whose particles are polygonal and straight edged. Specimens of contact rocks near the tonalite contain as accessory components sphene, biotite, quartz and zircon. The author calls attention to the peculiar cellular structure of the minerals he describes and asserts that it is a characteristic structure for substances formed by contact action. Aggregates of minerals exhibiting this 'contact structure' he would call contact-amphibolites, contact-gneisses, etc., in accordance with their composition.——In a note on the use of the gold washer's pan as an instrument for the separation of the heavy constituents of sands and decomposed rocks Derby[9] recounts his results of the examination of some granites and gneisses from the United States. In all the specimens examined there were found zircon grains, and these were especially plenty in granites from Otter Creek, Mt. Desert and the Hurricane Islands, in Maine, and from Ilchester, Md., and in the gneisses of Endfield, N. H., and Pascoag, R. I. Monazite is particularly abundant in the granite of Westerly, R. I., and in the gneiss of Randolph, N. H. Xenotime was found in the gneiss of Wessford, Mass., and allanite, rutile and apatite in most of the rocks mentioned. The author thinks that there is a reasonable probability that zircon and monazite may prove to be guide minerals by which eruptive rocks may be detected, however much they may be disguised by metamorphism. The occurrence of these minerals in the crystalline schists is an indication that these rocks are squeezed eruptives and not changed sedimentaries.——The conglomerate of Hoosac Mt., Mass., is overlain by an albite schist whose origin is ascribed by Wolff[10] largely to the replacement of clastic microline grains by albitic substance, with the attendant production of muscovite. Eight excellent figures in the author's article show the transition of decomposed fragments of feldspar into a fresh particle of albite in which all traces of clastic origin have disappeared. The

[8]Neues. Jahrb. f. Min., etc., B. B. vii, p. 471.

[9]Proc. Rochester Acad. Sci., 1, 1891, p. 198.

[10]Bull. Mus. Comp. Zool., xvi, p. 173.

original microline in the schist is often surrounded by a rim of new microline or of albite with the same orientation as the kernel. Arms from this extend into the nucleus, until finally the new material has entirely replaced the old.——In a few notes on some rocks from the Lake District, England, Hutchings[11] mentions briefly the characteristics of a biotite-quartz-andesite, and describes a series of hyalopilitic andesites, and one rock whose chemical composition is that of trachyte, while its mineral components are those of an andesite. He also briefly alludes to an augite porphyrite and a granular diabase.——Another occurrence of peridotite has been discovered in central New York, this time as a small dyke in a fault fissure near Manheim, seven miles east of Little Falls. The rock as described by Smyth[12] consists of phenocrysts of biotite and olivine in a groundmass of glass, biotite, magnetite, perofskite and a fibrous mineral supposed to be microlitic olivine.——Among the eruptive rocks of Flag-staff Hill, Boulder Co., Col., Palmer[13] has discovered quartz porphyries with phenocrysts of quartz, feldspar and black mica in a decomposed microfelsitic base, showing here and there evidences of flow structure. From its analysis the rock seems to be an andesite rather than a quartz-porphyry.——In a recent bulletin Mr. Diller[14] gives a full account of the cone of the volcano that erupted the quartz-basalt described by him a year or so ago, as well as an excellent discussion of the character of its lava.——A granitite from Farérolle in the Puy-de-Dôm, France, contains in addition to its essential constituents fluorite, autunite and torbenite.[15]

Quartz.—At Pitourees-en-Lordat, France, are beds of dolomitic limestone interlaminated with thin beds of talc schist and cut by veins of quartz in which Lacroix[16] has found some very remarkable twisted quartz crystals. Some of these are simply bent in one plane; others are now spiral, and each seems to have been affected independently of its neighbors. The force that produced the deformation in the shape of the crystals also strongly modified their internal structure, so that sections parallel to *c* show little areas differently orienated like the grains in a quartzite, while in sections perpendicular to *c* uniaxial

[11]Geol. Magazine, 1891, p. 536.

[12]Amer. Jour. Sci., April, 1892, p. 322.

[13]Proc. Col. Sci. Soc., iii, 1889, p. 230, and 1890, p. 351.

[14]Bull. U. S. Geol. Survey, No. 79.

[15]Gonnard, Bull. Soc. Franç. d. Min., xiv, p. 223.

[16]Bull. Soc. Franç. d. Min., xiv, 1892, p. 306.

particles are intermingled indiscriminately with those that are biaxial. On the contact with the veins fine masses of remolite have been developed in the limestone.——The quartz crystals of Suttrop, Vlotho and Bramsche in Westphalia, and incidentally crystals from other localities, have been thoroughly studied by Bömer,[17] especially with reference to their etched figures and electrical properties. The Westphalian crystals were treated with hydrofluoric acid, and sections cut from them parallel to oP were subjected to the action of the same reagent. The sections were also examined for circular polarization, and the entire crystals for electrical manifestations. The Vlotho and Bramsch crystals, the former of which occur in druses on marl and the latter implanted in white vein quartz in quartzite, are quite simple, while the Suttrop crystals, found loose in the soil overlying a quartzite composed almost exclusively of quartz crystals, are very complicated in structure. These consist usually of two or more individuals twinned, and often intergrown with others in the parallel position. The forms of the etched figures produced on oP vary widely. They depend upon the strength of acid used and upon the temperature at which the action takes place. With increasing strength of acid the figures suffer a rotation around the vertical axes of the crystals, and in the direction of its polarization, i. e. in right polarizing crystals, the rotation is to the right and in left-handed crystals to the left. Many other interesting results in connection with the etched figures of quartz were obtained by the author and some of them contradict the results of other investigators. With reference to the pyro-electrical properties of the crystals it was found that in small ones the negative and positive areas were irregularly distributed, while in large ones the distribution was more regular. Both large and small crystals act similarly when cooled in ether or in water. In each case the trapezohedral edges are positive.

Mineralogical News.—Among the wonderful pseudomorphs of serpentine from the Tilly Foster Mine, N. Y., Dana mentioned a cubic substance whose predecessor was unknown. Friedel[18] has reexamined this substance, and has found in it a central cone of amorphous serpentine, surrounded by a fibrous envelope of the same mineral. The arrangement of the fibres is so regular that the author concludes that the cubic form is due entirely to it, and that there is no reason for supposing the form to be pseudomorphic.——Excellent specimens of

[17]Neues Jahrb. f. Min., etc., B. B., vii, p. 516.

[18]Bull. Soc. Franç. d. Min., xiv. p. 120.

metacinnabarite from New Almaden, Cal., have given Melville[19] an opportunity to measure and to analyze its crystals. The mineral occurs in steep rhombohedral forms attached to quartz crystals, which in turn coat cinnabar crystals, resting in a compact mass of this substance and quartz. The terminations of the crystals are differently modified, the analogue pole containing principally the basal plane and rhombohedra, and the antilogue pole mainly steep scalenohedra. The analysis, made on impure material, gave:

S	Hg	Fe	Co	Zn	Mn	$CaCo_3$	Res.	Org. mat.	Total
13.68	78.01	.61	tr.	.90	.15	.71	4.57	.63	= 99.26

The organic matter was in the form of little black spheres imbedded within the crystals.——If the orthopinacoids of the members of the *heulandite* group be made the orthodome $\frac{1}{2}P\bar{\infty}$, Rinne[20] shows that its members may be regarded as forming an isomorphous group with stilbite, harmotome and phillipsite. The axial ratios of the various minerals come into accord with this view if half of c is taken as the unit in the members of the stilbite sub-group. The chemical composition of the different minerals is also similar enough to oppose no objection to the idea, the stilbites being mixtures of $R''\,Al_2\,Si_6O_{16} + 6Aq$ and $R_2\,Al_2\,Al_2\,Si_4\,O_{16} + 6Aq$, and the heulandites $R\,Al_2\,Si_6{\cdot}O_{16} + 6Aq$ for heulandite proper, and $R\,Al_2\,Si_6\,O_{16} + 5\frac{1}{2}Aq$. for epistilbite and brewsterite. The physical properties of all the substances mentioned are quite alike and their optical peculiarities are not different.——The *chloritoid* of a graywacke schist from the Champion Mine, Mich., is similar in many respects to masonite, according to Keller and Lane.[21] It is undoubtedly triclinic with B inclined 20° to the basal cleavage. Its pleochroism is C = yellow, B = blue, A = green. An analysis gave:

SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	K_2O	Na_2O	H_2O	Total
24.29	.28	34.00	10.55	20.52	tr.	1.29	.59	.97	.35	6.75	=99.59

Its hardness is 6.5 and density = 3.552.——Streng[22] again attempts to solve the composition of *melanophlogite* and succeeds in showing that the sulphur in its material is not in the form of sulphate but is more prob-

[19]Bull. U. S. Geol. Survey, No. 78, p. 80.

[20]Neues Jahrb. f. Min., etc., 1892, i, p. 12.

[21]Amer. Jour. Sci., Dec., 1891, p. 499.

[22]Neues Jahrb. f. Min., etc., 1891, ii, p. 211.

ably present as SiS_2, combined in some way with SiO_2, in the proportion $SiS_2 + 40\ SiO_2$. G. Friedel,[23] on the other hand, insists upon regarding the sulphur as occurring in the form of sulphate.——The *sigterite* from Sigterö, Norway, described by Rammelsberg[24] a short time ago as a new mineral, is acknowledged by this savant and by Tenne to be a mixture of eleolite and albite.——A greenish-white fibrous *talc* from Madagascar[25] has the composition $SiO_2 = 62.3$; $FeO = 2.6$; $MgO = 29.4$; $H_2O = 5.1$.——On a specimen of *dioptase*[26] in calcite from Central Africa Jannetaz has recognized octahedra of silver. This is the first report of the existence of native silver in that quarter of the globe.——Crystals of *barite* from Smithton and Sedalia, Pittis Co., Mo., consist of colorless portions enclosing yellow or white bands, in the latter of which Luedeking[27] and Wheeler find a large quantity of strontium and a small amount of ammonium sulphate. The composition of the crystals is $Ba\ SO_4 = 87.2$; $Sr_2SO_4 = 10.9$; $Ca\ SO_4 = .2$; $NH_4So_4 = .2$; $H_2O = 2.4$.——In consideration of the importance given by Tschermak to *meionite* in his discussion of the scapolite group Kenngott recalculates the formula of the mineral from new analyses recently published and derives $Ca_7\ Al_{10}\ O_{22}\ Si_{11}\ O_{22}$. He evidently places but little confidence in the Tschermak theory.——By mingling solutions of chromates, tungstates, molybdates, sulphates and selenates and studying the mixed crystals resulting Retgers[28] has shown that their alkaline and other salts are isomorphous, and that consequently when they are found as minerals they should all be placed in one group, which is trimorphous. The tellurates, on the other hand, are not isomorphous with any of the above mentioned compounds.—— The walls of cavities of the leucite basalt from the south side of Lake Laach are covered with brilliant little crystals that have been carefully examined by Busz.[29] They are *hematites* on which are implanted *rutile* crystals and little colorless *olivines* with a tabular habit parallel to $\infty P\bar{\infty}$. All are supposed to be products of sublimation.——A. Schmidt[30] records the results of observations on pebbles of *zircon*, *almandine* and epidote from Adelaide, Australia. The zircon has a

[23]Bull. Soc. Fr. d. Min., xiv, p. 74.

[24]AMERICAN NATURALIST, 1890, p. 1189.

[25]Jannetaz, Bull. Soc. Fr. d. Min., xiv, p. 66.

[26]Ib., xiv, p. 67.

[27]Amer. Jour. Sci., Dec., 1891, p. 495.

[28]Neues Jahrb. f. Min., etc., 1892, i, p. 56.

[29]Zeits. f. Kryst., 1891, xix, p. 24.

[30]Ib., 1891, xix, p. 56.

density of 4.695 and a composition of ZrO = 67.31; SiO_2 = 33.42. The author also describes cubical and octahedral crystals of pyrite from Porkura, Hungary.——*Enargite* from Cerro Blanco, Atacama, Chile, has a density of 4.51. It contains S = 32.21; As = 18.16; Cu = 47.96; Fe = 1.22; Zn = .57.——The *amber-like* substance[31] occurring in the sands of Cedar Lake, near the mouth of the Saskatchewan River, in Canada, has been found by Harrington[32] to have the following composition: C = 79.96; H = 10.46; O = 9.49; As = .09. Its hardness is 2.5 and density 1.055. From its reaction with solvents the author concludes it to be *retinite*.——Lacroix and Baret[33] find *bertrandite* at Mercerie in the Commune of La-Chapelle-sur-Erdre, France. It occurs in crystals elongated parallel to the base, associated with orthoclase, albite, quartz and apatite, in a granitite.

[31]Neufville, Ib., 1891, p. 75.

[32]Amer. Jour. Sci., Oct., 1891, p. 332.

[33]Bull. Soc. Franç. d. Min., xiv, p. 189.

BOTANY.

Yucca Pollination.—Probably the most interesting case of insect pollination known is that of *Yucca* by the little moth *Pronuba*. Under the title, "Yucca Moth and Yucca Pollination,"[1] Dr. C. V. Riley has lately summarized the results of observations and investigations on this interesting subject. Having myself verified many of the observations detailed, I have consented, at Dr. Bessey's request, to outline the process of pollination as at present understood, for the NATURALIST.

Dr. Geo. Englemann[2] was evidently the first observer to notice the Yucca moth and suspect its relation to the pollination of *Yucca*. Specimens of the moth were sent to Dr. Riley who christened it *Pronuba yuccasella*[3], and took up the investigation of the subject obtaining surprising results. The subject has since been much studied but to Drs. Riley and Trelease we are chiefly indebted for its development.

Self fertilization in *Yucca* is practically impossible. The stamens curve away from the pistil, in several cases very strongly, thus placing the pollen at some distance from the pistil. The pollen furthermore is glutinous and not easily detached and blown about; and the three lobes of the stigma are erect and so arranged that pollen dropping cannot fall into the stigmatic tube into which, it is further found, the pollen must be inserted some distance to be effective. Thus *Yucca* is entirely dependent on outside aid for pollination. Few species of plants, if any, depend upon one species of insect for pollination. Many have very numerous pollinators. Yuccas, however, appear to be actually dependent upon some one species of the little moth *Pronuba*. All species of *Yucca* east of the Rocky Mountains are apparently dependent upon *Pronuba yuccasella*.

[1]Third Annual Report Missouri Botanical Garden, 1892, pp. 99–158, 10 plates.—The reader is referred to this article for all details. The life history of *Pronuba* and *Prodoxus* (the bogus Yucca moth) is discussed, and descriptions of all known species are appended. Several species are described as new.

[2]"The Flower of Yucca and its Fertilization," Bull. Torr. Bot. Club, vol. iii, no. 7 (July, 1872), and "Notes on the Genus Yucca," Trans. Acad. Sci. of St. Louis, vol. iii, No. 1 (April, 1873).

[3]"On a new Genus in the Lepidopterous Family Tineidæ, with Remarks on the Fertilization of Yucca," Trans. Acad. Sci. of St. Louis, vol. iii, No. 1, p. 55 (April, 1873).

Pronuba is not attracted to the flower by nectar. As Trelease has shown,[4] large nectaries are present in Yucca, but frequently little nectar is produced. It is questionable whether that produced is ever utilized by *Pronuba* as she has never been observed to feed. This, as Riley observes, "adds to the importance of *Pronuba* by showing that the acts of collecting pollen and transferring it to the stigma do not result in food compensation." The eggs of *Pronuba* are deposited in the young Yucca capsule at this time and fertilization is necessary in order that the larvæ which feed on the maturing seeds may develop. Thus *Pronuba* insures the development of the seeds by pollinating the plant and is compensated by having her larvæ provided for, so far as food is concerned.

During the day the moth may be found in the flowers where they remain, their white color, being the same as the flower, protecting them. In early evening they begin their work. The males are stronger of wing and flit back and forth among the flowers. The female has a work to perform and she loses no time in frolic. Hers is the work of ovipositing and Yucca pollinating. It is surprising with what deftness, accuracy and understanding she proceeds about her task. She first begins by collecting a load of pollen, a stage difficult to observe but now authenticated by many observers. She may be seen quickly running to the top of the stamen, where she pauses, and bending her head down over the anther, with her tongue and maxillary palpi (wonderfully modified for this purpose) extended on the opposite side of the anther, she scrapes the pollen from the anther sacs, and with the aid of her front legs, shapes the gathered pollen into a little ball. She proceeds from anther to anther till a relatively large load is collected, often thrice as large as her head. With this, Riley observes, she flies to another flower usually before ovipositing. I have never observed the gathering of pollen but I have frequently seen the same moth pass from flower to flower and from plant to plant, ovipositing and pollinating in many ovaries without stopping to collect more pollen. In this way cross pollination, in most cases, must surely result.

Equipped with her load of pollen, *Pronuba* proceeds to the further work of oviposition. She enters a flower and may be seen frequently for several minutes resting with the head toward the base of the flower, feeling around with the tentacles or slowly crawling around. Suddenly she awakens and with surprising activity runs rapidly around in the flower over the stamens and finally, in a few seconds, takes position

[4] "The Nectary of Yucca," Bull. Torr. Bot. Club, vol. xiii (August, 1886), p. 135.

for ovipositing, with the head usually toward the stigma backing down a little, with the body between two of the stamens, her legs straddling them. When a favorable point is found, which is generally slightly below the middle of the ovary, she rests for a short time, then raising the body slightly, thrusts the lance-like ovipositor into the soft tissue of the young ovary, penetrating into an ovarian cavity, where it is retained for a short time while the egg is being deposited. The ovipositor and oviduct are beautifully modified for this purpose. Oviposition only takes place in newly opened flowers, the first or second night after opening, the ovary usually being susceptible to fertilization only during these nights. The moth seems instinctively aware of this and never oviposits in an old flower. She evidently in running about the flower before oviposition, as explained above, seeks and learns whether the flower is in a receptive stage and whether it has been already punctured.

No sooner is oviposition completed than the moth proceeds to the act of pollination. She runs to the top of the pistil and bending over the stigma, works her head rapidly up and down, forcibly thrusting the pollen down into the stigmatic tube. The act of oviposition is usually followed by the act of pollination. This occurs so regularly and promptly that, as Trelease expresses it, "the moth seems to have it on her mind to perform the latter as a sequel to the former." When more than one egg is deposited in the same pistil it is thus pollinated more than once, and in some cases where as many as a dozen or more eggs are deposited in the same pistil pollination must be very profuse. There is a necessity for an abundance of pollen, however, as each of the three cells of the ovary contains hundreds of ovules. When the load of pollen is exhausted the moth has been observed to replenish her supply.

The larva of *Pronuba* in its development uses up only from 10–12 seeds, so even in those capsules where the most abundant larvæ develop, hundreds of good seeds are nevertheless produced. The few seeds destroyed may well be sacrificed to insure the pollination and development of the others.

About the time the pod begins to harden the full-grown larva bores its way out, makes its way to the ground, where after boring several inches below the surface it forms its silken cocoon. The larva transforms to the imago state a few days before the flowering of the Yuccas, and makes its way to the surface, where the moth escapes.

The interdependence of Yucca and *Pronuba* is thus seen to be very marked. It is a mutual relationship closely approaching that of sym-

biosis. The beauty and perfectness of adaptation is, however, yet more marked than I have outlined. Prof. Riley observes that Yuccas are very irregular in flowering, that a plant which flowers this year may not next year. This irregularity might prove fatal to *Pronuba*, but a beautiful device is found to meet it. Yucca moths are equally irregular, a large percentage of the moths failing to issue the year following oviposition, but are retarded until the second, third or fourth years after oviposition.

What is the meaning of the phenomena here observed? We are dealing, it is seen, with a case of pollination widely different from other known cases. In the most highly specialized protandrous flowers as in *Impatiens*, pollination by an insect or humming bird is entirely accidental. In the protogynous flowers of *Aristolochia* and *Arum*, so much admired for their beautiful device for securing cross pollination, carrying the pollen is an entirely unintentional action on the part of the gnats and flies, they going merely where they are allured. In the most perfect device of the many beautiful ones in orchids, the pollinia merely accidentally adhere to the insect and are carried from flower to flower as he flies about in search of nectar. Indeed, of all the beautiful and ingenious devices by which cross pollination is accomplished by animate beings, so far as known, *Yucca is the only case where this apparently intelligent pollination occurs. In all other cases it is accidental.*

Similar cases of apparently intelligent action among insects frequently occur, where food is provided beforehand for the larvæ. Such illustrations are the collecting of honey, the storing up of insects and spiders which have been killed for the purpose, or the laying of eggs in a branch or fruit stem which is afterwards girdled to provide dried material for the larval development. Between all of these devices, however, and Yucca pollination, there is, it appears to me, a wide difference. Such devices are the *inherited resultants* of easily understood facts or laws. The difference is merely a difference of degree truly. Such a difference as exists between the trained botanist and the rude understanding of the native American. The latter would understand that a girdled limb would in all probability die. Such things even his dull intellect will notice, as illustrations occur every day before his eyes. He could hardly be made to understand, however, that there is such a thing as sex in plants, although illustrations demonstrating this occur just as commonly under his eye. The nature of the problem is different. I do not credit the Yucca moth with a full understanding of what she is doing but it does seem that

either she or her ancestors must have had some idea of what was being accomplished. The point here seized upon and utilized in the development by natural selection is so different from those usually utilized. The points usually developed into permanent habits by natural selection and inheritance are, commonly occurring, easily understood laws. I, however, surely believe with Riley and others that this perfect adaptation of Yucca and *Pronuba* must be the result of natural selection, the gradual modification of some archetypal form.

However this development took place, one watching *Pronuba's* actions at the present time, so full of purpose and understanding, can hardly fail to conclude with Riley that it is not "blind instinct" alone that guides her.—H. J. WEBBER, *Shaw School of Botany.*

ZOOLOGY.

Trematodes.—All authors agree that Trematodes are provided with a superficial cuticle which is pierced by numerous minute canals, but their statements in regard to the origin of this cuticle are very contradictory. Thus Ziegler looks upon the cuticle as a metamorphosed epithelium, Schneider and Minot consider it the basal membrane of an epithelium which has been lost in the parasitic life of the worm, while Leuckart describes it as a product of the subcuticula. To these three theories Dr. Brandes, of Halle, now adds a fourth[1] of which the following is a brief resumé:

Trematodes do not possess any subcuticula in the true sense of the word; the subcuticula described by Leuckart and others is parenchymatic tissue which, together with a similar tissue found between the muscles, Brandes names ectoparenchym, to distinguish it from the endoparenchym, *i. e.*, the parenchym in which the genital organs are imbedded; *there is, however, a true cuticle present, which is a product of the subcuticular glands;* the cuticle is not pierced by canals.—C. W. STILES.

Fishes of Ohio.—Oberlin College has begun the publication of a "Laboratory Bulletin." The second number, which has just appeared, contains a "Descriptive list of the fishes of Lorain county, Ohio," by the museum assistant, Lewis M. McCormick. In all 89 species are enumerated, and *Etheostoma wrighti* is described as new.

[1] G. Brandes, Zum feineren Bau der Trematoden, Zeitschrift f. w. Zool., 1892, Bd. liii, 4.

The paper is illustrated with 18 figures reproduced from the publications of the U. S. Fish Commission.

Necturus maculatus in the Hudson River.—In Prof. Cope's Monograph of North American Batrachia (United States National Museum Bulletin No. 34) an interesting feature of the geographical distribution of the Mud Puppy—*Necturus maculatus* Raf.—has been overlooked, viz., the fact that through the agency of canals the species has been introduced into the Hudson River and has become abundant both in the river and in its various tributaries.

Prof. Cope gives the habitat of the species as follows: "Ranges throughout the tributaries of the great lakes and the Mississippi, as well as the rivers that flow into the Gulf of Mexico and the Atlantic Ocean as far north as the Tar River, North Carolina."

Only one New York locality is cited, Grass River, St. Lawrence county. This is a tributary of the St. Lawrence River, and its source is not very far distant from the source of the Hudson. The only other locality cited which is at all near the Hudson is Burlington, Vermont. This locality also is in the drainage area of the St. Lawrence. Both the localities cited are covered by the statement "ranges throughout the tributaries of the great lakes," but there is nothing to indicate that the species inhabits the Hudson and tributaries.

De Kay, in 1842 (Natural History of the State of New York), predicted that the species would some day be found inhabiting the Hudson. De Kay's exact words on the distribution of the Mud Puppy in the State of New York were as follows: "This curious and interesting aquatic animal is common in the northern and western parts of the State. It is found in Lake Champlain, and is particularly abundant at the Falls of the Onion River and at the outlet of Lake George. It inhabits Lakes Erie, Seneca, and the other lakes in the western districts of New York. It has been found in the Erie canal, and will doubtless, ere long, be found to have reached the Hudson River." De Kay's prediction has come to be a fact. Whether the species came from the west through the Erie canal or from Lake Champlain through the Champlain canal, it is now so abundant in the neighborhood of Albany as to be somewhat of a nuisance. The city reservoirs are plentifully stocked with the species. A short time ago an individual was washed out of one of the fire-plugs in the heart of the city, and report says that another became wedged in the water pipes of one of our school-houses and had to be cut out in order to allow the water to flow.

As the Hudson and Delaware Rivers are connected by a canal which runs from Kingston on the Hudson to Port Jervis on the Delaware it is not improbable that the Mud Puppy will at some future time be found in the Delaware. At present no record of its occurrence in the Delaware is known to me, and probably it has never yet been found in that river. At least no mention of the species is made in Dr. C. C. Abbot's Catalogue of the Vertebrates of New Jersey, published in 1868, nor in Julius Nelson's revision of the same catalogue, published in 1890.

The presence of the species in the Hudson and its tributaries is worthy of note, as it is one of the very few instances in which we have apparently good evidence that the habitat of an aquatic animal has been unintentionally enlarged through human agency.

WM. B. MARSHALL, *Albany, N. Y.*

The Foot in the Amniota.—It is well-known that the Dorking fowl is the only living bird which, in the adult condition, possesses a five-toed foot. Messrs. G. B. Howes and J. P. Hill have recently studied this form and they conclude[2] that the two inner toes are the result of fission of the hallux and that the variation in number of phalanges in the supernumerary toe is caused by degree of longitudinal subdivision. The hallux metatarsal is proximally prolonged into a rod of bone running parallel with the other metatarsal and articulating upon the inner condyle of the tibio-tarsus, a reversional characteristic unknown in other living birds, through which Archæopteryx had already passed and for which we must go back to the last aberrant tetradactyle Dinosaurs. In the general portion of this paper they show that this extra toe is not to be interpreted as a reversional reappearance of a usually missing hallux but rather as a splitting of the hallux normally present. Going farther they point out that the phalangeal characters of the different classes of air-breathing vertebrates throw light upon the phylogeny. In all mammals[3] the phalangeal formula is 2, 3, 3, 3, 3, or less; that of the Sauropsida 2, 3, 4, 5, 4, or less by reduction, while that of the Amphibia is 2, 2, 3, 4, 3, or less. In no known Amphibian, living or extinct, has the second digit more than two phalanges, and hence neither the sauropsidan or the mammalian foot can be derived from that of the Amphibia except by a process of intercalation of which we have no other evidence. This in

[2]Jour. Anat. and Phys., xxvi, 395, 1892.

[3]Except Cetacea, where Kükenthal argues that the supernumerary phalanges are dismembered and duplicated epiphyses.

connection with Cope's discovery of the mammalian condition of the limbs in the Theramorpha is strong evidence against the derivation of the Mammalia from the Batrachia; both Mammals and Sauropsida must have come from an ancestor with the phalangeal formula 2, 3, 4, 5, 4, or more.

Twisting of the Umbilical Cord.—In man and many mammals the umbilical cord is twisted but the twisting may be either right or left handed and the number of turns may vary. To explain this twisting several hypotheses have been advanced, the last being that of Prof. F. J. Allen.[4] The twisting consists in the twining of the two arteries about the single vein of the cord, and this involves an increase in length of the arteries greater than that of the vein. To test this Allen devised a model of rubber tubes and cord and found that the hypothesis was fully supported by the model. It is not easy to see what is the gain to either fœtus or mother by this twisting.

General Notes—Lower Invertebrates.—Dr. R. von Lendenfeld publishes[5] a preliminary arrangement of the calcareous sponges. The work is based upon the labors of Haeckel and Poléjaeff. Twenty-one genera are recognized.

Arthropoda.—Emile Deschamps claims[6] that the recently established genus Abacola of Prof. C. L. Edwards is synonymous with Thyopsyllus of Brady.

Dr. Paul Marshal describes a hermit crab (*Pagurus striatus*) which he found inhabiting a left-handed shell of *Neptunea contraria*. The abdomen of the individual was normal and showed the same lack of symmetry as its fellows, and on trial was found to hold itself equally well in both dextral and sinistral shells.

E. A. Birge publishes[7] a list of 64 species of Cladoceran Crustacea from Madison, Wisc. *Latonopsis occidentalis* and *Alona lepida* are described as new. A new species of Moina is indicated but not described.

Vertebrates.—C. K. Averill catalogues for the Bridgeport Scientific Society 246 species of birds found in the vicinity of Bridgeport, Conn.

[4]Jour. Anat. and Phys., xxvi, 300, 1892.

[5]Stz. Akad. Wien., Bd. c. Abth. 1, p. 4, 1891.

[6]Bull. Soc. Zool. France, xvii, p. 68, 1892.

[7]Trans. Wisc. Acad. Sci., viii, 1892.

EMBRYOLOGY.[1]

Spina Bifida and the Blastopore.[2]—Prof. Oscar Hertwig has made an important contribution to teratology and attempted the solution of some fundamental morphological problems in a paper that is disappointing from many points of view, though undoubtedly of considerable value.

In order to produce polyspermy in the frog, eggs were kept two to four days in a moist chamber before artificial fertilization was attempted, or else the female frogs were isolated for four to six weeks. In either case very many eggs developed normally, yet it is assumed that the hundred monstrous forms picked out were the results of some injury made upon the egg by the above treatment and that polyspermy took place.

This latter assumption is in no wise supported by any direct observations, but rests merely upon the previous work done by the author and others upon other eggs.

Passing over some interesting cases of irregular and of partial cleavage we will briefly describe the three sorts of monstrosities assumed to be imperfect conditions of gastrula stages.

In the first case there is a large yolk plug appearing at the surface of the embryo all along the dorsal, median region, so that such a monstrous embryo of five to seven days looks as if there were a huge blastopore with a medullary fold along each side of it and a plug of yolk cells projecting between these folds. At each end of this plug a depression leads ventrally, a sort of fore gut and hind gut. At the posterior end two elevations represent a sort of double tail. In fact, the medullary groove or tube and the notochord are *double* and pass along each side of the yolk plug.

In a second set of abnormalities the embryos have advanced so far as to have eyes, external gill slits, a short tail and a heart. The tail is bent up at right angles to the trunk and anterior to it is a small plug of yolk coming to the surface on the median dorsal line. Internally the nerve tube and the notochord are double on each side of the yolk plug, or open blastopore, but anterior to that form normal, single structures. Posteriorly they run as paired organs into the tail, which

[1]Edited by Dr. E. A. Andrews.

[2]Archiv f. mikros. Anat., xxxix, 1892, pp. 353–492, plates 16–20.

usually appears a single structure externally but may be quite deeply bifid or double from the base. Posterior to the tail a median groove may run in to the digestive tract as an anal pit.

The third class of monstrosities presents only a slight departure from the normal, having a prominent yolk plug not closed in when the larva is even older than in the second class. This plug occupies the position of the normal blastopore or anus of Rusconi, posterior or ventral to the tail, and is due to a failure of the ventral lip of the blastopore to grow up as soon as it should have done.

In interpreting these peculiar abnormal embryos the author assumes that they are all cases of arrested development, that the yolk plug is in each case really the blastopore, which has failed to close at the proper time, thus causing the median dorsal parts of the embryo to appear as paired structures along the lateral lips of the huge, open blastopore, whereas, they normally would first appear as single structures along the median dorsal line when the blastopore had closed there. The retardation in the closure of this dorsal blastopore has thus kept dorsal structures separated till they have so far developed as to form half structures widely apart; later, when the blastopore closes, these halves may grow together more or less perfectly and so produce a normal form.

It is to be regretted that individual cases were not actually watched so that there might be no doubt concerning the real value of these great, dorsal, hernia-like yolk plugs.

The author thus definitely adopts the position, hitherto held only by Roux and opposed by Schultze, that the frog larva develops along what was the light-colored side of the egg, the blastopore closing in successively from the head towards the tail along this aspect of the egg. He regards the blastopore in the frog as a median, dorsal opening extending the whole length of the trunk, normally closing in till the anus of Rusconi and the definitive anus are left as evidences of its posterior portion, while anteriorly a median "rückenrinne" and the lateral origin of mesoblast and the relations of the notochord give evidence of its existence through the whole length of the animal.

Increase in length would not take place anterior to the closing blastopore so much as at the actual point of successive closing, the blastopore advancing posteriorly *pari pasu* with its gradual closing.

Hertwig takes a definite stand as a supporter of the concrescence theory of His, modifying it somewhat when extending it to all vertebrates by regarding the neurenteric canal as also a part of this dorsal blastopore.

In discussing the blastopore and concrescence in various vertebrates a sharp distinction is drawn between the true blastopore or depression leading into the digestive tract and the growing edge of the blastoderm, "Umwachsungsrand" as it may be called. Only part of the latter may, in some cases, become the blastopore. Thus in the bony fish the blastopore consists of a short transverse portion or sickle and a longitudinal constantly elongating and closing median groove running forward from the sickle. The sickle is gradually formed more and more from the edges of the blastoderm, the "Umwachsungsrand," till the latter is eventually used up in this way, becoming converted into sickle-groove, which in turn is gradually closed in along the median, dorsal line of the embryo. In the shark, however, the "Umwachungsrand" soon leaves the sickle and the partly closed in portion of the blastopore and then closes by itself; is not then part of the blastopore. In the chick or in a reptile this separation is such an early one that the true blastopore is quite removed from the edge of the circular growing edge of the blastoderm, which then is not to be reckoned as part of the blastopore at all.

The anus of vertebrates is regarded as the posterior part of this elongated blastopore, hence the vertebrate tail is morphologically, as in some of these monstrous frog embryos, a double structure growing out from the right and left lips of the blastopore. The tail, with its neural tube, notochord, mesoblastic somites and portion of the entoblast is then not a prolongation of the trunk, but a dorsal outgrowth of different value. It elongates by a transfer of the "Wachsthumszone" to its tips and in the same manner as the trunk elongated. How it is possible for the closing in process and growth to take place posterior to the tail and also at the tips of the tail the author does not explain.

Having brought forward some arguments for his coelom theory and replied to certain criticisms of Götte the author next discusses at length the relation of the blastopore to various abnormal forms in vertebrates. He takes the view that the formation of several embryos from a single egg is to be referred back to the formation of as many gastrula invaginations in that egg. The difference between such multiple monsters in different groups of vertebrates is then due to the differences in the gastrulation, to the various possible ways in which multiple invaginations may arise in different sorts of eggs. The apparent absence or great rarity of double monsters in the Amphibia may be due either to the small size of the egg and difficulty of double invagination or it may be that such doubleness is early obliterated by following fusion

into normal structures. In the bony fish the tendency to the formation of double-headed monsters would be due to the method of closure of the blastopore, two invaginations being easily brought together to form a common trunk. In the chick, however, this cannot so readily take place, but embryos arising peripherally on the blastoderm tend to have their heads fused while the tail ends are not brought together by the fusion of any growing edge forming the blastopore and so remain separate.

This leads to the consideration of the conditions producing double germs from a single egg. A single egg after the first cleavage has the power to produce two individuals of normal structure but half the normal size. This is the necessary result of the process of cell division as previously explained by the author, and has recently been shown experimentally by Driesch, Chabry and not really negatived by Roux, when his work is interpreted as seems just.

The first two cells of a cleaving oosperm develop into right and left halves only because of their association together; separated each would form a perfect organism.

The reason for the manifestation of this double power in double monsters is to be sought in the action of forces before cleavage. Of these the author regards polyspermy as the most efficient. This view the author upholds in spite of the many negative experiments that have been made upon echinoderm eggs (and upon frog eggs in the present paper, granting that polyspermy actually took place in the frog's eggs used).

Here it may be noted that the author assumes throughout that the frog's eggs were injured by the treatment he gave them, and that more than one sperm entered each abnormal one.

There is, however, no evidence of this in the present paper; we find only a certain similarity between the treatmont of the eggs and the treatment of echinoderm eggs when polyspermy actually ensued.

Back of the effects produced by entrance of many sperms there is the abnormal state of the egg allowing of this multiple fertilization.

This state of the egg with the effects of polyspermy remain latent until later several invaginations may result and from these eventually double monsters are formed if there be not a complete fusion of the first rudiments.

The connection between polyspermy and the formation of double monsters is thus by no means a direct nor a simple one, yet of the many factors concerned the effects of polyspermy are, in the author's estimation, the important ones.

ENTOMOLOGY.

Harvest Spider Notes.—A recent study of a large number of specimens of the common striped harvest-spider, from all portions of the United States, leads to the conclusion that the northern and southern forms so intergrade that they should rank as a single very variable species, instead of being considered two species as now recognized. The southern form having appeared in the original publication before the northern, has precedence, and should as now be called *Liobunum vittatum* (Say) while the northern form is *Liobunum vittatum dorsatum* (Say). An illustrated paper giving a more complete account of the species will appear in the NATURALIST at an early date.

During the spring just passed I collected a number of the harvest-spiders described by Dr. Wood as *Phalangium formosum*, and since placed by myself in the genus *Forbesium*. They were confined in vivaria and fed on plant-lice; but instead of depositing eggs as I had hoped they would, they continued growing and casting their skins until they evolved themselves into another genus and species—*Liobunum ventricosum* (Wood). This fact accounts for their sudden disappearance each spring. It is not unlikely that the specimens referred to *formosum* may include, in other localities, the young of other species. If the southern *Forbesium hyemale* proves to be also the immature form of another species, the genus will become a synonym.—CLARENCE M. WEED.

Protective Resemblance in Trombidium.—While collecting the past spring I have frequently stooped to pick up what I supposed to be the common New England red mite (apparently Say's *Trombidium sericeum*) only to find one of the seed-capsules of one of our abundant Sumachs, which in the spring are widely scattered over the ground. A few feet away the resemblance between the Trombidium and these detached capsules is very striking, the color often being precisely alike. If the mites are at all subject to attack by birds this resemblance must enable many to escape.—C. M. W.

The South Dakota Insectary.—The experiment stations are gradually perfecting their facilities for the study of injurious insects, several of them already having insectaries for carrying on observations

and experiments. A recent bulletin from South Dakota gives the following account of the new insectary at Brookings:

Recognizing the necessity of facilities for rearing insects in a situation where all external conditions could be controlled, as well as of a suitable place for keeping the collections and apparatus of the department, the board of trustees last year authorized the construction of a building for the entomological department. This was occupied about June 25. It is a structure 16x32 feet in size, with wing 12 feet square. In the main part is the general office and work room, 16 feet square, a well finished room, provided with desk, tables, balances, shelves for collections, &c. Here are kept a general collection of all orders of insects, chiefly collected in this locality; some economic collections, showing the transformations, work and parasites of some of the common injurious insects; samples of various insecticides, and a few bee supplies.

The rearing-room, or insectary proper, occupies the remainder of the main part of the building. It is an unfinished room with dirt floor, lighted by five large windows. It is as yet but partially fitted up, owing to the fact that the rearing season was almost past when we moved into the building last spring. Breeding cages and other devices for this line of work will be in operation this year.

The wing on the east side of the main building is devoted to bee-keeping and storage of machinery, &c. The bees are placed on a low shelf along the side of the room, the faces of the hives toward the outside. Horizontal slits through the wall, one immediately in front of each hive, give the bees egress. This arrangement is called a house apiary, and presents several advantages in our circumstances. The hives are safe from violent winds and are in a very convenient place for working with them, as by nearly closing the door the room can be darkened until the bees will not fly in it.

Wasps and Humming Birds.—My attention was recently called by Prof. H. G. Jesup to a row of English white birch trees in Hanover, N. H., which had been bored by woodpeckers. Although most of the holes were old, the sap was evidently still exuding about some of the trees as they were visited by swarms of flies, and many wasps, particularly the "white faced hornet" (*Vespa maculata*). There were also several humming birds (*Trochilus colubris*) eager for a taste of the sap. But whenever one of the latter approached a wasp would dash savagely at it and drive it away. This was repeated over

and over again on different days, and it only rarely happened that the birds were rewarded by a short suck of the coveted liquid.—C. M. W.

Recent Publications.—Bulletin No. 27 of the U. S. Division of Entomology consists of reports on the damage by destructive locusts during 1891 in California, Colorado, Kansas and other Western States. The reports were prepared by Messrs. Bruner, Coquillet, and Osborn, field agents of the Division.

The April, 1892, Bulletin of the Ohio Experiment Station consists of a discussion by Mr. F. M. Webster, of the "Insects which burrow in the stem of wheat." Seven species are included. * * * Mr. Lawrence Bruner's report as entomologist to Nebraska Board of Agriculture for 1891 consists of a short, illustrated treatise on corn insects. * * * Dr. J. B. Smith's report for 1891 as entomologist of the New Jersey Experiment Station contains several excellent practical discussions of injurious insects, with many good illustrations. * * * The March Bulletin of the South Dakota Station, and the May Bulletin of the Iowa Station contain valuable entomological articles. Baron C. R. Osten-Sacken[1] has a paper of additions and corrections to Dr. S. Wendell Williston's catalogue of the Asilidæ of South America published last year. The shrimp, *Palæmon ornatus*, has recently and suddenly appeared in great numbers in the Hunter River of Australia.

[1]Berliner Entomolog. Zeitshrift for 1891, xxxvi, 417, 1892.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Cornell Medical Society.—May 24, 1892.—Prof. B. G. Wilder read a paper upon the "Appendix of the Cæcum, Its Origin and Destiny." After showing how this dangerous organ is developed in the individual the speaker took up the subject of its development in the animal series, and showed that while it might possibly be present in the wombat it is certainly present in the lemurs, but not in the ordinary monkeys. When, however, we come to the true apes (gibbons, chimpanzees, orangs and gorillas) there is found an appendix far more dangerous than in man even. Dr. Wilder suspects that the presence of this dangerous appendix in the apes may be an important element in holding them back and enabling man with a less dangerous one to outstrip them in the race of life. No doubt the appendix is a rudiment or remnant of what in our remote ancestors was a useful organ. It is being slowly eliminated. In view of the fact, however, that so great a number of persons suffer or die from disease of the appendix (it is reported that at least one person is operated on daily for it in New York), and from the fact that it seems now to have no function except to act as a death-trap, Prof. Wilder renews the suggestion made several years ago that as we vaccinate to avoid small-pox, so it might be advisable to remove this objectionable and useless organ from children and thus give them a better chance to survive. It might be hoped also that as in the struggle for life nature seems to take advantage of useful variations, she would take the hint and leave off this unwelcome organ altogether.

Many specimens were shown illustrating the points brought out. One of great personal interest was the appendix lately removed from one of the Cornell professors, the removal of which, no doubt, saved his life. The professor was present and added greatly to the interest by a discussion of the subject from the standpoint of evolution and personal experience.

SCIENTIFIC NEWS.

First Tile Fish in Ten Years.—The United States Fish Commission schooner "Grampus" returned, Aug. 7, from an examination of the deep water fishing grounds south of Martha's Vineyard with a tile fish, the first which has been caught in 10 years. The mysterious disappearance of this fish in 1882 was the subject of considerable discussion and comment at the time, and its cause was variously accounted for. The fish was first discovered in 1879 by a Gloucester fishing schooner, which secured a large number of them. Specimens were sent to fish experts and the markets, and it was at once recognized as a fish of value for its food qualities.

As it was found within a few hours' sailing distance of New York, the fishermen saw that it gave promise of an important additional fishing ground. The fish commissioner, realizing the important nature of the discovery, began a careful investigation of the entire region in order to determine the extent of the grounds, the abundance of the fish and the best means of catching them. The investigation was pursued during the summers of 1880 and 1881, specimens being taken on nearly all the trips made by the commission vessels to this region. The result of these trips showed that the fish were abundant, and that the hopes based upon the discovery were well founded.

In the spring of 1882, however, enormous quantities of this fish were found dead upon the surface of the ocean, from Nantucket to Cape May, and since that time none of them have been taken, despite the efforts put forth at frequent intervals to find them.

In 1889 a systematic study of the relations of the gulf stream and the Labrador current was instituted by the commissioner, Col. M. McDonald, with the idea of establishing a connection between the changes in the temperature of the water and the movements of the schools of fish. During the course of the investigation for the past three years it was found that a deep warm water band was approaching the edge of the continental platform nearer and nearer each year. The idea suggested itself that if this band came in contact with the continental platform throughout its whole extent, the feeding grounds of the tile fish, which was a tropical fish, might be possibly so extended that it would find its way far to the northeast and up to the point where the land naturally left the end of the platform at the position where the fish was first discovered. If, then, this band should be with-

drawn, the first place at which it would leave the edge would be in the great bend of the coast opposite New York, and the water there would be too cold for the fish to live in. The consequence would be that those fish that had found their way farther east, as well as those upon their ground, would be subject to conditions which would bring about the result accomplished; namely, their wholesale destruction.

The "Grampus" went out to the above named region off Martha's Vineyard, and, finding by the temperature observations that this warm area has been very much increased, the trawl lines were set and the fish caught.

It is now the intention of the commissioner to follow up the success by mapping out the warm area to the southwest, setting trawls to determine the relative abundance of the fish, and to put the information in proper shape to be utilized by the fishermen.

—A NEW monthly journal devoted to natural science has appeared in England, and is published by MacMillan & Co. It is supported by several of the younger English scientists, and is ably conducted. It is a valuable addition to our current scientific literature, especially as it furnishes a full opportunity of discussion for naturalists of Neolamarkian proclivities, which has not been hitherto obtainable in the pages of the older journal, Nature. We observe a tendency to rather undiscriminating criticism in its editorial notes, but this is better than the suppression and mutilation of articles which has characterized its predecessor in the same field.

—THE Marine Biological Laboratory at Wood Holl has just completed its most successful season. It has had a corps of 17 officers, instructors and assistants, and an attendance of 38 investigators and 62 elementary students; or total of 117.

Among the recent promotions at the Johns Hopkins University are the following: Dr. E. A. Andrews, associate professor of biology; Dr. William B. Clark, associate professor of geology; George P. Dreyer, associate in biology; George H. F. Nuttall, associate in bacteriology and hygiene.

Recent appointments at Harvard University: William Henry Howell, associate professor of physiology; Henry Parker Quincy, instructor in histology; Franklin Dexter, demonstrator of histology; Henry Jackson, demonstrator of bacteriology; Daniel Denison Slade, lecturer on comparative osteology; William Francis Ganong, instruc-

tor in botany; Thaddeus William Harris, instructor in geology; Charles B. Davenport, instructor in zoology; William M. Woodworth, instructor in microscopical anatomy.

The University of Kansas has established a periodical under the name "The Kansas University Quarterly." The first number, dated July, 1892, contains the following papers: Kansas Pterodactyls, Part I, and Kansas Mosasaurs, Part I, by Prof. S. Wendell Williston; Notes and Descriptions of Syrphidæ, by W. A. Snow; Notes on Melitera dentata Grote, by V. L. Kellogg; Diptera Brasiliana, Part II, by Prof. Williston.

The Société Zoologique de France starts the year 1892 with 277 members.

Herman Burmeister, zoologist, died at Buenos Ayres May 1, 1892. He was born Jan. 15, 1807, at Stralsund, studied at Greifswald and Halle, and was elected to the chair of natural history at the latter university at the death of Nitsch. Owing to the troubles of 1849–50 he went to South America, and with the exception of two trips to Europe he spent the rest of his life there. In 1861 he became the director of the Museum of Buenos Ayres, and nine years later became the head of the faculty of sciences in the University of Cordoba. He is best known for his early work on entomology and his later papers describing the physical geography, zoology and paleontology of South America.

Chairmen of Committees on Anatomical and Biological Nomenclature.—CORRECTION.—In a circular, "American Reports Upon Anatomical Nomenclature," issued last winter by Prof. Wilder as Secretary of the Committee of the Association of American Anatomists, in the third paragraph of the third page, the Chairman of the Committee of the Anatomische Gesellschaft should be Prof. A. von Kölliker, and the Chairman of the American division (appointed in 1891 by the American Association for the Advancement of Science) of the International Committee on Biological Nomenclature should be Prof. G. L. Godale. Prof. Wilder desires to express his regret for the errors, due in the one case to his own misapprehension and in the other to a clerical mistake.

C. L. Herrick, formerly of the University of Cincinnati, and recently elected professor of biology in the University of Chicago,

has accepted a call to a chair of biology and neurological research in Denison University, Granville, Ohio; Prof. Wm. G. Tight retains his position in charge of geology and botany. Recent gifts of about $75,000 are to be largely devoted to the erection and equipment of a scientific building.

The Journal of Comparative Neurology will also be published from Granville under the patronage of Denison University.

ERRATA.

On page 637 in the August No. the date 1882 should read 1862. In the review Erlanger's work upon Paludina (same number) page 709, line 13 for "mouth" read "mantle;" page 712, line 4, for "chiton" read "Amphineura."

RECORD OF NORTH AMERICAN ZOOLOGY.

Continued from Vol. XXVI, p. 724.

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